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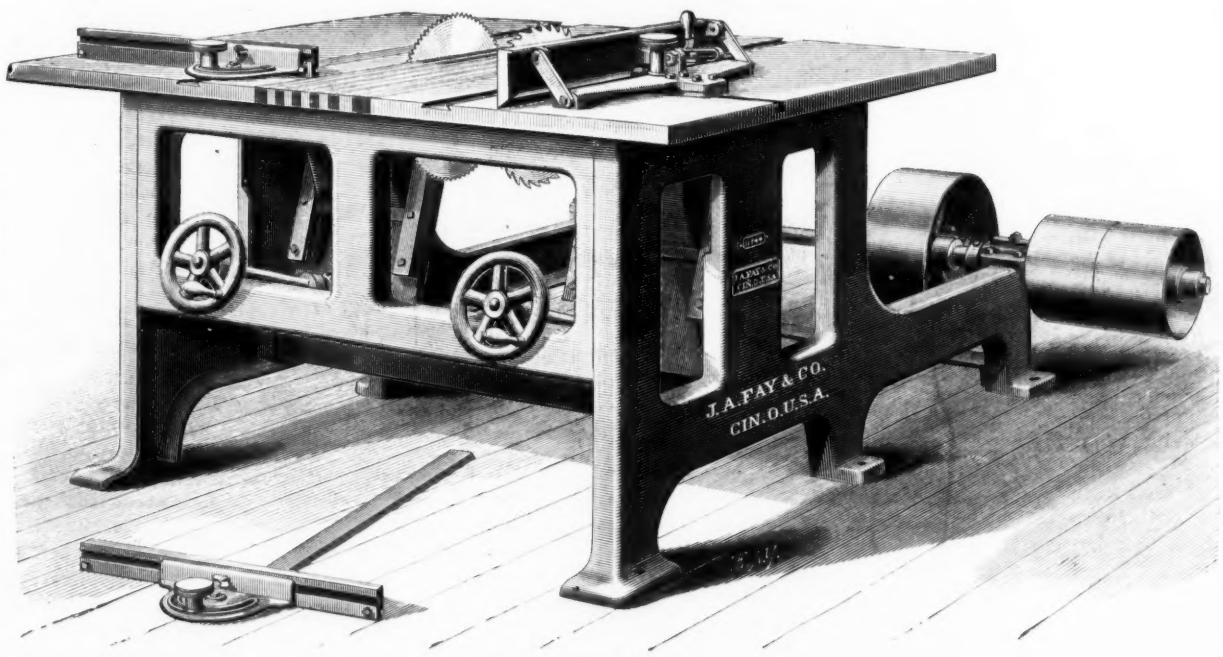
Cabinet-Makers' Double Saw Machine.

The accompanying engraving represents an improved double circular sawing machine having two independent saw arbors, both adjustable vertically to any desired height to suit the thickness of the material to be worked. It is especially adapted to the needs of cabinet-makers, carpenters, or pattern makers, and will be found very efficient for any class of work requiring a machine of this character, as it is designed for ripping, squaring, rabbeting, mitering, grooving, beveling, and other operations.

The frame is of iron, very heavy and strong, the arbors large in diameter, with long bearings, each arbor and frame being adjusted independently of the other in planed gibbed ways, so arranged as to always retain the same tension of the belt at any point to which they may be elevated. The hand wheels for this are in front, and convenient to the operator, and the table always remains at the same height.



DOUBLE SAW MACHINE.

The top is of iron, planed true, and is 4′ 2″ long by 4′ 11″ wide. It is fitted upon one side with an adjustable fence, which can be set to different angles, and is moved in planed ways to and from the saw. The other side carries a cutting-off slide provided with stops to govern the length to be cut, which can also be set to varying angles. T-slots for miter or cutting-off slides are placed close to each saw.

The space between the two saws is of wood, and can be thrown back, allowing free access to the saws, which may be either both rip, or a rip and a cross-cut, according to the work to be done. Grooving, rabbeting, plowing, or other heads can be used in place of either saw, when desired. The frame is of sufficient length to give long belts from the countershaft to the arbors. The tight and loose pulleys on the countershaft are 12″×6″, and should make 600 revolutions per minute.

The machine is made by J. A. Fay & Co., Cincinnati, Ohio.

The Dangers of the Centrifugal Machine.

BY FRANK H. RICHARDS.

I think that little has been said in the columns of the AMERICAN MACHINIST about the centrifugal machine. It is really one of the important machines of the day. It is one of those machines that are not likely to ever be superseded, but its use is coming to be daily more extensive. Applied to a variety of purposes, it finds universal employment in woolen mills and laundries. Its sole function, of course, is the removal of liquids by the centrifugal force imparted to them. It may be said to apply a force equivalent to the force of gravity, but of much greater intensity. It is with safety quite possible, by this machine, to give to a liquid which we wish to drain from a porous material, a force five hundred times that of gravity; hence the value of the machine, especially as an economizer of time is an important element of cost in manufacturing operations. That I do not exaggerate, let the figures show. A centrifugal machine with basket 36″ diameter is in some establishments constantly run at 1,000 revolutions per minute. By the formula in all the books—I take it from Trautwine—the centrifugal force equals:

$$\text{Wt. of the body} \times \frac{\text{Square of number of revs. per min.}}{2{,}935.} \times \text{Rad. in ft.}$$

Now, for our purpose, we do not care for the total weight of the load in the basket. We may take one pound of water in the load as well as the whole of it. Then in our 36″ basket at 1,000 revolutions per minute, we have:

$$\frac{1 \times 1{,}000{,}000 \times 1.5}{2{,}935} = 511.$$

This, of course, is the value at the periphery only of the basket. When the fact is put in this way we may reach some appreciation of the enormous force developed by this machine, and the consequent danger involved. But a realization of the danger is being enforced in a more practical way by the frequent bursting of the machinery, entailing loss of life and limb and serious destruction of property. These casualties do not attract the attention that elevator accidents do, because the machine is not so public in its function, nor, as yet, so numerous. Where an accident is fatal it gets into the local papers and is soon forgotten.

The problem of safety for the centrifugal machine is a curious and difficult one, from the number of conditions involved which apply to no other machine. High speed of revolution is employed for many purposes, all wood-working machinery, dynamos, fans and emery-wheels. Emery wheels are probably the most dangerous of these, as they frequently burst. But they may be tested, as they always should be, by being run at excessive speed before being sent out, and they are always becoming safer because they are wearing smaller. The centrifugal machine cannot be tested in the same way, because the danger is not in the machine alone, but in the machine with its load; and there is such a difference in the loads treated that no shop test can be of much value. Loose, porous material lets the water out easily, and the load is often lightened one-half before full speed is reached. A load of wet hides will lose little in weight, and will be quite wet and heavy after running at high speed for a long time. The manufacturer, whose interest is of course always in the safety of his machine, might say that "this machine has been run in the shop at —— revolutions per minute, the basket containing —— pounds" of dry material. I do not know how a fair test could be made with wet material, except with the same material, and under the same conditions, as in the factory where the machine is to be used. And when the material and conditions of treatment are known, the manufacturer who would guarantee the safety of his machine at a certain speed would soon find himself in trouble, for, without exception, every centrifugal machine grows continually weaker. The looseness of the working parts, that comes from wear, is one item, but the basket grows weaker from abrasion and corrosion, and where acids are employed it is eaten away very rapidly. I have seen parts of bursted baskets that certainly had not one-quarter of their original strength.

Remembering that the centrifugal force varies with the square of the velocity, a small increase of speed upon a machine already near the limit of safety may often prove fatal. Ignorant and impatient men will increase the speed of these machines until they find out, in the only absolutely certain way, just how much they will stand, and how much they will not stand. In some establishments the speed of the motive power is unsteady. The engine sometimes races or runs away, and the centrifugal machine attains excessive speed. I have been told that there are makers who build a steam-driven centrifugal machine, the steam engine being a part of it, and with no governor to the engine. It is within my knowledge that a certain carpet factory, having four centrifugal machines of large size, with an engine attached to each, had the governors removed from those engines. I am of the opinion that killing a man under, and by reason of such an arrangement should be held to be willful murder.

I have sometimes, for my private satisfaction, done a little computation as to the permissible relative speeds for machines of different sizes. The figures invariably seem to say that either the smaller machines are run slower than need be, or the larger machines are run too fast; and this finds corroboration in the fact that the casualties are mostly with the larger machines. A machine with 24″ basket, in the line of service with which I am familiar, is not usually run above 1,200 revolutions per minute. Running it safely at that speed, supposing the load to weigh 100 pounds, how fast should a 40″ machine be run to be equally safe?

By our formula:

$$\frac{100 \times (1{,}200)^2 \times 1}{2{,}935} = ?$$

In this case we have to consider the weight of the load, and this should vary as the cube of the diameter of the basket, which gives us 463 pounds for the load of the 40″ machine. Then we have the statement:

$$\frac{463 \times x^2 \times 1\frac{1}{3}}{2{,}935} = ?$$

We may drop the constant denominator, common to both. Then we have for the 24″:

$$100 \times (1{,}200)^2 \times 1 = ?$$
$$100 \times 1{,}440{,}000 \times 1 = 144{,}000{,}000$$

and, consequently, for the 40″:

$$463 \times x^2 \times 1\tfrac{1}{3} = 144{,}000{,}000$$
$$771x^2 = 144{,}000{,}000$$
$$x^2 = 186{,}770$$
$$x = 431.$$

Here, by our formula, x happens to represent the revolutions per minute of the 40″ basket; but we have to remember and allow for the superior strength of the 40″ basket. The case of the basket is thicker and wider than the 24″. Say that it is in section double that of the 24″, and I think it is less than that, then the permissible speed may be increased in the ratio $1 : \sqrt{2}$, then

$$1 : \sqrt{2} :: 431 : —$$
$$1 : 1.414 :: 431 : 610.$$

But I have not known a 40″ basket to be run so slowly as that of late years. 40″ machines are run from 800 to 1,000 revolutions per minute.

The centrifugal machine has been much improved. It is made better and more substantial in every detail. The most valuable improvement is undoubtedly in the application of the self-balancing, or rather the self-centering principle. The load to be treated is necessarily more or less unevenly distributed in the basket, and consequently out of balance; and where, as of old time, the spindle of the basket is run in rigid bearings, both the bearings and the whole frame and foundation of the machine, and the basket itself, are subject to great strain and jar in consequence. With the self-centering devices in use the basket is free to move lat-

erally sufficiently to enable it to revolve, not around the center of the spindle, but about the center of gravity of the combined weight of basket and unevenly distributed load. And this is accomplished so well that the machine may be run at the highest speeds without even bolting it to the foundation. With this improvement comes the temptation to run the machines at still higher speeds, so that it is doubtful if they are any safer; but this is the fault of those who use them, and not of the manufacturer.

Modern Locomotive Construction.

BY J. G. A. MEYER.

SIXTY-SIXTH PAPER.

Counterbalance—Continued.

In a number of locomotives the outer form of the rim of the driving wheel is uniform throughout. Such a wheel is shown in Fig. 358. There we notice that a portion of the rim, opposite to the crank, is cast solid, and the remaining portion of the rim is cast hollow. But, in many cases, the extra weight of metal gained by casting part of the rim solid, is not sufficient for counterbalancing the whole weight applied to the crank-pin; consequently we often find the whole rim cast hollow, and of equal dimensions throughout, with a certain portion of the rim opposite the crank filled with lead, so as to obtain a greater weight in the same amount of space than can be obtained by casting a portion of the rim solid. Hence, it frequently happens that the weight of the lead in the rim, and its effect as a counterbalance, must be calculated.

Let Fig. 401 represent a part of a driving wheel whose rim is cast hollow, and of equal dimensions throughout. The section around the center line $b\ c$ represents a cross-section of the rim; and Fig. 402 represents the same section on a larger scale. The portion of the rim from the rib a to the rib a_6 is filled with lead. It is required to find the weight of the lead, and its effect as a counterbalance; that is to say, to determine the amount of weight applied to the crank-pin which the lead in the rim can counterbalance.

This problem includes two distinct problems, namely, to find the weight of the lead; second, to find the effect of the weight of the lead as a counterbalance.

For the sake of simplicity we shall leave the ribs a_2 a_4 a_6 cast in the rim out of consideration, and proceed as if the hollow part of the rim from the rib a to the rib a_6 had been a clear space and then filled with lead.

Weight of the Lead.—In looking at this counterbalance, or body of lead, from a theoretical standpoint, we may consider this body or solid to be generated by a surface which is equal in extent to the cross-section of lead revolving about the center of the axle, and this surface we may call the generating surface. The contents (that is, the number of cubic inches) of this solid is obtained by multiplying the area of the generating surface by the length of the path (or arc, in this case), described by the center of gravity of the generating surface; the product will be the number of cubic inches in the counterbalance. And lastly, the number of cubic inches multiplied by the weight of one cubic inch of metal will be the weight of the counterbalance. Consequently we have the following:

Rule 49.—Multiply the area in square inches of the cross-section of the lead by the length of the arc in inches, described by the center of gravity of this cross-section; the product will be the number of cubic inches in the counterbalance. This last product, multiplied by the weight of one cubic inch of lead, namely, .41 pound, will be the weight of the counterbalance.

From the foregoing we see that in determining the number of cubic inches in the counterbalance two distinct factors enter into our calculation, namely, the area of the cross-section of the lead, and the length of path which the center of gravity of this section will describe.

The outline of the cross-section of the lead is represented by the outline $d\ e\ h\ c\ n\ k\ j$ of the cavity in Fig. 402. The area of this cross-section can be found by Rule 48. Thus: Draw the line $b\ c$ perpendicular to $p\ r$. If the outline of the section is symmetrical, the line $b\ c$ must be drawn through the center of the section; if the outline of this section is not symmetrical, we first draw a line $s\ t$ (any length) parallel to line $p\ r$, and touching the curve $i\ c\ o$ in one point, as c, and then through this point, that is, the point of tangency, draw the line $b\ c$ perpendicular to $p\ r$, as before.

Let us assume that the outline of the section is symmetrical. Through the point e draw a line $e\ e_2$ perpendicular to the line $b\ c$. Divide the distance from e_2 to c into any number of equal parts, say five; through the points of division f_2, g_2, h_2 and i_2 draw lines perpendicular to $b\ c$, cutting the outline of the section in the points f, g, h, i. Suppose now that we find, by measurement, the line $e\ e_2$ to be equal to $\frac{3}{4}$ inch; $f\ f_2 = 1\frac{1}{8}$; $g\ g_2 = 1$; $h\ h_2 = \frac{7}{8}$; $i\ i_2 = \frac{3}{4}$; and c, of course $= o$; also, the distance, such as $f_2\ g_2$, or $g_2\ h_2$, that is, the distance between any two successive ordinates or perpendiculars, equal to $\frac{9}{16}$ inch.

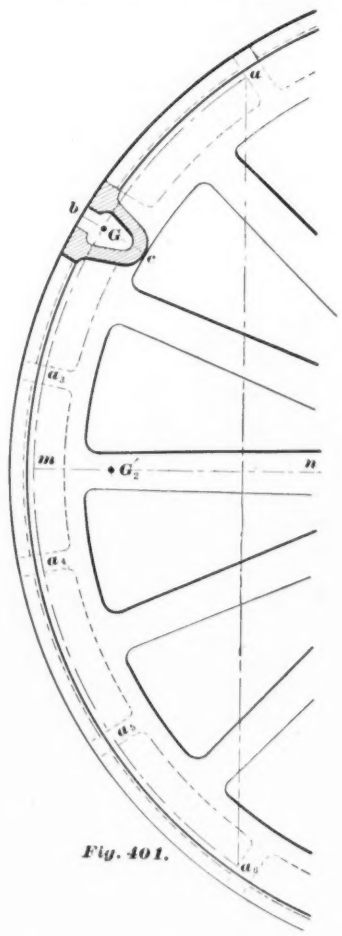


Fig. 401.

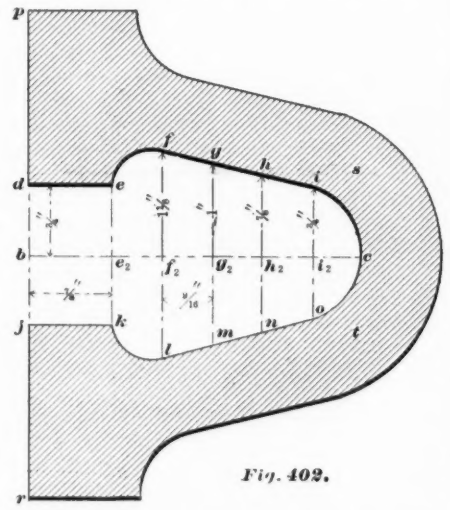


Fig. 402.

The area of the surface $e_2\ c\ h\ f\ e$ will then, according to Rule 48, be equal to

$$\left(\frac{\frac{3}{4}''}{2}+1\tfrac{1}{8}''+1''+\tfrac{7}{8}''+\tfrac{3}{4}''+\tfrac{9}{16}''\right)\times 1\tfrac{9}{16}=2.10+\text{sq. ins.}$$

To this we must add the area of the rectangle $b\ d\ e\ e_2$; and since $b\ e_2$ is equal to $\frac{7}{8}$ inch, and $e\ e_2 = \frac{3}{4}$ inch, we have $.875\times 75 = .65+$ square inch; hence $2.10+.65=2.75$ square inches, which is the area of the section above the line $b\ c$; and $2.75\times 2 = 5.5$ square inches, which is the total area of the cross-section of the lead.

If the outline of the section is not symmetrical as we have assumed it to be, then we find area of the surface above the line $b\ c$, and that below the line $b\ c$, each one separately, in a manner precisely similar to the foregoing, and add the two together; the sum will be the total area of the surface.

Our next step will be to find the length of the path described by the center of gravity of the cross-section of the lead. Cut a templet to the outline $d\ e\ h\ c\ n\ k\ j$ of the cavity (Fig. 402), and find its center of gravity G by the method shown in Fig. 378 or 385, and mark this point G in its correct position from b in the section shown in Fig. 401. From the center of the axle describe an arc passing through the center G, and terminating in the sides of the brackets a and a_6. This arc will represent the path of the center of gravity G of the cross-section, while this cross-section, which we have called the generating surface, is revolving about the center of the axle. Now suppose that, by measurement, we find the length of this arc from a to a_6 to be equal to 57 inches, then the total number of cubic inches in the lead will be equal to the product obtained by multiplying the area in inches of the cross-section, previously found, by the length in inches of the arc $a\ a_4\ a_6$, hence we have $5.5''\times 57'' = 313.5$ cubic inches. Multiplying the cubic inches by the weight of one cubic inch of lead we have $313.5\times .41 = 128.535$ pounds, which is the total weight of the lead in the rim.

Effect of the Weight of Lead as a Counterbalance.—Our next step will be to determine how much of the weight applied to the crank-pin will be counterbalanced by the weight of the lead in the rim. To do this we must find the center of gravity G_2 (Fig. 401) of the whole amount of lead, and the correct distance between this center of gravity and the center of the axle. But here a little difficulty arises; we see that the thickness of the lead is not uniform, that is to say, the lines *ke*, *lf*, *mg*, etc., in the cross-section of the lead, as shown in Fig. 402, are not equal in length; therefore we cannot find the center of gravity of the lead by the method shown in Fig. 385, or by any method previously given; hence for finding the center of gravity of the lead we adopt the following method:

In the first place we shall assume that the area of the cross-section of the lead is infinitely reduced, so that the whole counterbalance will be represented by the arc $a\ m\ a_6$ (Fig. 401), which is described from the center of the axle and passing through the center of gravity G of the cross-section; and we shall also assume that the whole weight of the lead is concentrated along this arc, or, in other words, the weight of this arc $a\ m\ a_6$ is equal to the whole weight of the lead. Join the extremities a and a_6 of this arc by a straight line, which will be the chord. We have now reduced the conditions of the problem to those of a very simple one, for we have now only to find the center of gravity of the arc $a\ m\ a_6$.

In J. Weisbach's Theoretical Mechanics we find that the center of gravity of an arc of a circle must lie in the radius drawn through the middle of the arc, because this radius is an axis of symmetry of the arc; consequently in our problem the center of gravity G_2 of the arc $a\ m\ a_6$ must lie in the line $n\ m$, which is drawn through the middle n of the arc to the center of the axle. Again, we find that the distance from the center of gravity of the arc to the center from which the arc has been described is to the radius of the arc as the chord is to the arc. To indicate these proportions by symbols, let,

Length of the arc be represented by b
Length of the chord " " " s
Length of radius " " " r
Distance of center of gravity " " y

Then we have

$$y : r :: s : b. \quad \text{Consequently}$$

$$y = \frac{s\,r}{b}$$

From the foregoing we can establish the following rule:

Rule 50.—To find the center of gravity of the lead in the rim, multiply the length in inches of the chord joining the extremities of an arc which is described from the center of the axle and passing through the center of gravity of the cross-section of the lead by the radius in inches, and divide this product by the length of the arc in inches; the quotient will be the distance from the center of the axle to the center of gravity of the arc.

We have already seen that the length of the arc $a\ m\ a_6$ is 57 inches; now suppose we find by measurement that the chord $a\ a_6$ is equal to $48\frac{1}{2}$ inches, and the radius equal to $29\frac{1}{2}$ inches, then the distance of the center of gravity G_2 of the lead in Fig. 401 from the center of axle will be equal to

$$\frac{48.5''\times 29.5''}{57''} = 25.1 \text{ inches.}$$

We have found that the weight of the lead is equal to 128.535 pounds, consequently the moment of the force due to the weight will be equal to

$$128.535\times 25.1 = 3226.22+$$

If we now assume that the length of the crank is 12 inches, then our lead will counterbalance a weight appplied to the crank-pin equal to

$$\frac{3226.22}{12} = 268.85 \text{ pounds.}$$

Design, Construction, Repairs and Management of Marine Steam Engines and Boilers.

BY W. H. HOFFMAN.

EIGHTH PAPER.

I will still continue the description of the connecting rod, as I consider this member one of the most important, and entitled to more than a general explanation.

In my last paper, I described the necks, center and lower stub end, mentioning in a general way the cap bolts for crank-pin boxes. I fixed the combined net area of the smallest portion of these bolts as equal to the upper neck of the rod, which gave 4″ diameter at the bottom of the thread. Now these bolts will have a fit entirely through the stub end, and into the upper half box for a distance of $3\frac{1}{2}$″, and the same arrangement is used for the cap, and lower half box. The diameter of the bolts at these fitting points will be $4\frac{5}{8}$″, but in the space between the fitting places the bolts have a diameter of $4\frac{3}{8}$″, as formerly stated. The object of the reduction in diameter is to save a long fit of $16\frac{1}{4}$″ through the two half boxes. These bolts will have hexagon heads, and nuts $7\frac{1}{4}$″ across the flats; the heads being $4\frac{3}{8}$″ deep, and the nuts $5\frac{3}{8}$″ deep; the latter well locked by check rings. The corners of the bolts, where they join the heads, will be rounded with a $\frac{1}{2}$″ radius, and the holes in the stub ends will be rounded with a $\frac{3}{8}$″ radius, so that the bolts can never become "corner bound." These little matters of detail must be looked after in the drawing room, and every radius should be as carefully marked as any other lines on the drawing.

The caps for holding the crank-pin boxes in position will be of forged steel, notched to receive the tongue on the lower half of the box, and bored $4\frac{5}{8}$″ for the bolts. The caps will be of the same width as the stub ends, 10″, but as they are not subjected to the same leverage as the stubs, their thickness will be less than the latter. A cap is simply a beam supported at both ends, and receiving its load under quite uniform distribution.

The initial piston loads may, under some conditions, reach 42 to 45 tons, and this will be resisted by the cap or beam, with supports $18\frac{5}{8}$″ apart. In order to have a proper fit on the raised portion of the bolts, the thickness of the cap, where the bolts pass through, should be at least $3\frac{1}{2}$″, and this thickness is more than ample for the load. As we introduce the central notch in the cap, however, and by so doing disturb the true line of the tension chord, we shall increase the thickness to a point that will give a factor of 10, and this calls for a thickness at the center of $4\frac{1}{8}$″ while the ends will be $5\frac{3}{8}$″ thick, exposing a sectional area, after deducting the holes, of 29 square inches at each end.

The corners of the notch in each cap must be rounded on the same radius as that of the

stub end, and there will be dowels on each half box, to prevent side motion. The outer corners of the caps should be rounded with a $\frac{3}{8}$" radius, to prevent them from being mutilated in handling. Suitable holes drilled and tapped in convenient places on the caps, and fitted with eye bolts, will provide a ready method for removing these pieces when necessary.

Next in order we have the crank-pin boxes. Unfortunately a set of crank-pin boxes cannot be made of good cast-iron, for the reason that the best of this metal is liable to fracture under sudden heavy blows. A cast-iron box will not warp under heat to a troublesome extent; not half as much as a gun-metal or phosphor bronze box. Steel castings, and mild forged steel, have been used for heavy boxes, but thus far have not found much favor with marine engineers, though I believe a mild steel box, lined with the best quality of white metal, is far superior to a bronze or gun-metal box. Gun-metal and bronze boxes now have the lead, because they are strong, and easy to fit in place, and these are the only good features about them. Boxes made of the last named metals cannot be thin, and consequently must be heavy. The writer knows of an instance where a set of marine engine crank-pin boxes were removed and scraped for ten consecutive trips, and were finally (by altering the radius) replaced by new boxes $2\frac{3}{8}$" thick instead of $1\frac{3}{4}$". In the old boxes the sides next to the straps were $\frac{1}{2}$" thick, but in the new boxes they were 1" thick. The old boxes were once measured when hot, and found to be distorted $\frac{3}{64}$ of an inch in 13 inches.

Making boxes too thin at the sides is one of the greatest faults in engine design, and yet we find a dozen too thin to one that is thick enough to keep itself straight. When the sides are so thin, they receive the heat so quickly that they begin at once to expand, and then buckle, the result being that they are thrown by the buckling against the pin or journal on each side, thus instantly stopping the flow of oil in its path over the entire surface of the pin. Of course there can be but one result, viz.: intense frictional resistance, excessive heating, and extensive cutting.

Our crank-pin boxes are bored $13\frac{1}{2}$", with oil space allowance, of course, and the thinnest spot at the sides is $1\frac{7}{8}$" thick; not much chance for warping here. If the investigator wishes to satisfy himself on the question of thick and thin boxes, let him, if convenient, examine a set of good sized crank-pin boxes, say from 8" to 14" diameter, that have sides about $\frac{1}{2}$" thick. We can be sure that some time these boxes have been very hot, and if he will look on the inside of the strap, and the outside of the boxes, he will see where they have hugged one corner on each side, leaving the other portion without a sign of support. When such boxes are first fitted to these straps in the shop, the work is pronounced good; and it probably is, but wait till they are placed in position on board ship, and are running with a surface velocity of five feet per second, under a pressure of 400 pounds per inch, and then we have quite another kind of a box. Let them once get hot, then remove them and show them to the workman who fitted them, and he will disown them at once.

I said in my last paper that I would describe a proper system of oil holes, grooves and channels. In some of the recent works on friction, I notice that the writers instruct us to cut oil grooves from the central opening to the extreme ends of the boxes. After much experience in this matter, I cannot endorse the system laid down in some of these books. I have usually found it easy enough to get the oil into a set of boxes, but the trouble has been to keep it there. Proper lubrication does not consist in circulating a large quantity of lubricant in at one point, and immediately out at another, but does consist in introducing the amount of oil required, and replenishing the same automatically when the natural waste calls for more. When a pair of boxes are fitted to a crank-pin there is no trouble in making any good and suitable lubricant enter the space allotted to it, and we must only be sure that it does not run towards and out of the ends of the boxes too freely. I always make a circular channel, say $\frac{3}{8}$" from each end of the box, $\frac{3}{8}$" wide and $\frac{1}{2}$" deep, and calculate the length of the box as the net distance between these channels. In these circular end channels I place several layers of thick felt, the inner surface of which lightly touches at all times the pin or shaft journal. The upper half of the box has in the center portion of its bearing surface, and running in line with the journal, a groove $\frac{5}{16}$" deep and $\frac{3}{4}$" wide, extending across the box to within 1" of the circular channels. The oil is received in this top channel from the automatic feeders, and easily distributes itself the entire length of the journal; the felt stoppers at the ends preventing all but a very small portion from escaping. The lower half of the box has a slot and an oil pocket in connection with it, directly at the center of the box. The slot will be the same length as the one in the upper half, but in the lower slot will be placed a rope of felt or similar material, which will collect and distribute, at the alternate turning points in the revolution of the pin, the oil that naturally reaches the lowest point in the box by gravity.

When steam is admitted to the bottom side of the piston there is a free space for the oil to reach the center of the pin, and on the next turning point it reaches the dope, which is constantly wiping, or laying the lubricant on to the surface of the pin. Thus we have a self-oiling attachment traveling with the pin, an attachment simple in construction and easy to adjust and clean. Perfect automatic lubrication will insure continuous running, even in heavy weather, if the main boxes are of such form and thickness as those just described, and the saving in oil is very great.

Formerly the lubrication of a marine engine was one of the after considerations, but now it is one of the first things that receives the attention of the draftsman.

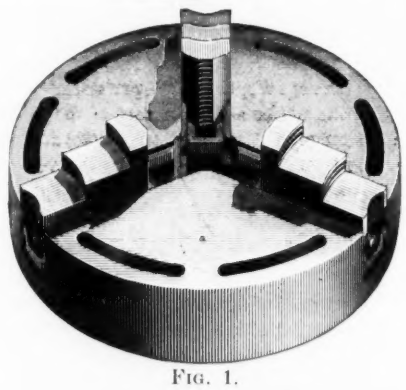


FIG. 1.

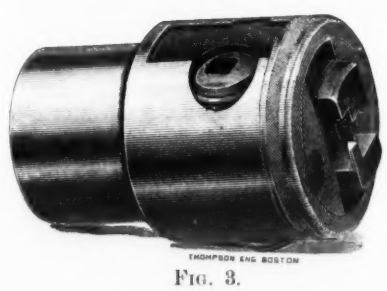


FIG. 3.

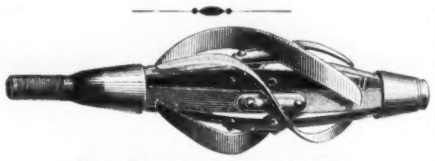
Some New Chucks.

The illustrations presented herewith show some new designs of chucks by the Westcott Chuck Co., Oneida, N. Y.

Figs. 1 and 2 show latest improvements in a scroll combination lathe chuck. The body of the chuck has been made considerably heavier to give increased rigidity, parts which were formerly cored out being now cast solid, and the smaller sizes being made of malleable iron. All the jaws and screws are now made of steel.

As is well known, there is difficulty in holding a pulley by the rim in a chuck, especially if the rim be quite light, because the pressure which can be put on it by the chuck jaws is limited by the strength of the rim. For this reason the circular slots are provided through the body of the chuck, so that bolts can be passed through, and pulleys or similar work secured without putting much strain upon the rim. Fig. 2 shows the arrangement of the parts, and it will be noticed that the jaws are reversible.

Figs. 3 and 4 show a new drill chuck, which is similar to the side screw chuck heretofore made by this company, but has diagonal tongued jaws, made of tool steel and hardened. By the diagonal arrangement of the tongue, increased gripping power is obtained and the grooving of the drill shank prevented if it should slip in the chuck.



The Weston Flue Cleaner.

The accompanying cut represents a new flue cleaner, which possesses some points of merit, entitling it to consideration by those who have boiler flues to keep clean.

The spiral scrapers are of steel, and each one is riveted to the center of a flat steel spring, as shown. The ends of these springs, which enter the conical thimble at the right of the cut, are not fastened rigidly to it, but enter it, and have the ends bent inwards; then there is what is called a spreader, which goes inside of the springs at this end, and the bolt, the head of which is seen projecting at the end, is tapped into it. This spreader is conical, and has flat places upon it, upon which the springs bear, and by tightening the bolt the spreader is drawn into the thimble and the springs spread out as much as may be desired, either to allow for different sized flues, or to change the degree of compression when pushed into a flue. It will be noticed that it is so arranged that it is not only smallest at each end, but also yields to pressure more easily at each end than in the middle, which is a desirable feature, and allows the scraper to yield to any unusual obstruction, or to go through rough welded flues. The fact that the scrapers do not project beyond the solid end prevents them being broken by coming in contact with the back wall when pushed through. The inventor is Edward D. Weston, Jackson, Mich.

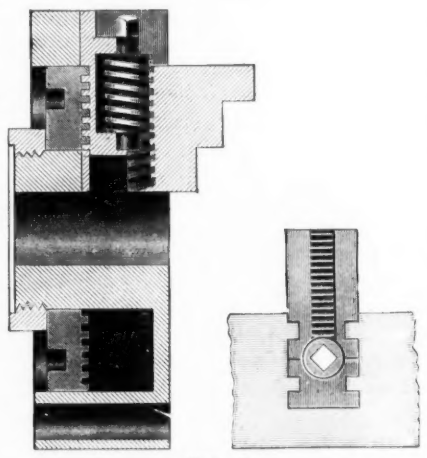


FIG. 2.

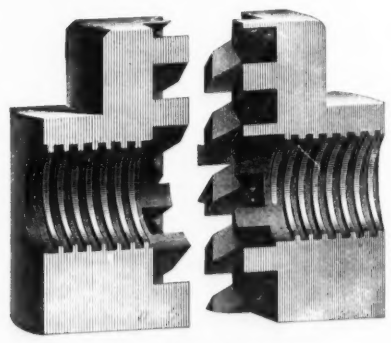


FIG. 4.

The following remarks, taken from *Engineering*, relating to the Manhattan Bridge, over the Harlem River, now in progress of construction, indicates the view taken by men on the other side of the Atlantic, of the political influence on our city government. "The preliminary and most arduous work of the Commission—the letting of the contract—having been accomplished, they were free from the conflicting interests of the politicians, contractors, etc., and were able to devote some of their time to a consideration of the structure. No one who has not bid on New York City contracts can realize the full force of this statement. Men of influence are constantly coming to the surface, and by a careful distribution of liquor, and subsequent controlling of ward politics in this city, are often able to upset or advance any scheme for improving the public condition of affairs. Fortunately, under the able administration of Mayor Hewitt, whose honesty of purpose and integrity are undoubted, these political manipulations have grown difficult, if not almost impossible, and New York City to-day is breathing freer than for many previous years."

A Suggestion to Manufacturers.

P. S. Kelley, of Elizabethport, N. J., sends us a sketch of a vise, which he says they find of great convenience. It is an ordinary vise, with the exception that the jaws have longitudinal V-slots for holding round work to be operated upon. Mr. Kelley is of the opinion that some manufacturer would do well to put a vise of this kind on the market, as every machinist has had trouble enough wrestling with the problem of holding a piece of round work in the vise to make him appreciate these longitudinal slots, which do not injure the vise for other use.

Considerable sport has been made of our navy, and many people insist that it could accomplish little or nothing in case of trouble. The attention of such people is called to the fact that the North Atlantic squadron, anchored off New Orleans recently, was run into by a tow of scows, and instead of the North Atlantic squadron being annihilated, as many would suppose would be the case, the scows were sunk, involving a loss of $100,000. Now let the critics who have been poking fun at our navy, hide their heads in shame.

A correspondent of the *English Mechanic* says: "I once asked a foreman in a well-known bell foundry whether putting silver in a melting pot was of advantage. He replied: 'Of great advantage—to the founder, as the silver sinks to the bottom; the founder pours off the copper and tin, and when the silver has cooled, puts it in his pocket!' It may be that a bell made entirely of silver would sound well; but this is mere conjecture."

We have received from the American Iron and Steel Association their *Annual Statistical Report*, containing statistics of the American and foreign iron trades for 1887, compared with 1886, and a brief review of the present condition of the iron industries in foreign countries. It contains valuable information for those interested in the iron and allied trades. It is published by the American Iron and Steel Association, Philadelphia, and is furnished to any one at $2.

The letter-carriers in the large cities of the United States have been obliged to work from ten to fourteen hours per day, although eight hours was the rule in other Government work. By recent enactment eight hours is made a day's work for letter-carriers. Eight hours is enough. If there is any one who does not believe this, let him tramp around New York for that time with the average load of a letter-carrier.

According to the report of an English steam boiler inspection and insurance company, published in *Engineering*, there were among the boilers used on land, in England, twenty-eight explosions during 1887, those used on farms heading the list with five, which is significant when it is remembered that England is a manufacturing, rather than an agricultural country.

Mr. Davis, of Lodge, Davis & Co., Cincinnati, Ohio, recently called on us. His mission in the East is to purchase tools for their new shops, the construction of which we have previously noticed. Mr. Davis reports business in the line of machine tools which they build, as excellent.

Notes on the Expansion of Steam.

By Richard H. Buel.

FIFTH PAPER.

It may make the subject plainer to work out one of the cases in detail, giving rules at length, and afterwards to present the complete solution of all the cases, with the algebraic formulas applicable to any assumed data.

The case chosen is that of $\frac{1}{4}$ cut-off, and the problem to be solved may be briefly restated:

Required the proper dimensions of the cylinder of a steam engine, to develop 150 net horse-power, initial pressure of steam, 100 pounds per square inch, back-pressure, including friction pressure, $17\frac{1}{2}$ pounds per square inch; apparent cut-off, $\frac{1}{4}$; pressure at point of cut-off, $97\frac{1}{2}$ pounds per square inch; clearance in equivalent length of cylinder, $1\frac{3}{16}$ inches; ratio of compression same as the real ratio of expansion and piston speed, 450 feet per minute. Since the per cent. of clearance cannot be calculated until the dimensions of the cylinder are ascertained, the real ratio of expansion is unknown, and it will be necessary to make an approximate calculation, on the supposition that there is no clearance. This will give the dimensions of the cylinder with sufficient accuracy for calculating the fraction of clearance.

The mean absolute pressure up to cut-off is the arithmetical mean of the initial pressure 100) and the pressure at cut-off (97.5), or

$$\frac{100+97.5}{2}=98.75$$

pounds per square inch.

The mean effective trial pressure is found by adding the mean pressure up to cut-off (98.75) to the product of the pressure at cut-off (97.5) by the hyperbolic logarithm of the apparent ratio of expansion (1.3863), dividing the sum by the apparent ratio of expansion (4), and subtracting the mean back-pressure (17.5) from the quotient, or

$$\frac{98.75+97.5\times 1.3863}{4}-17.5=41$$

pounds per square inch.

The effective horse-power to be obtained per square inch of piston for this mean effective pressure is the product of the mean effective pressure (41) by the piston speed (450), divided by the foot pounds of work per minute in a horse-power (33,000), or

$$\frac{41\times 450}{33{,}000}=.562.$$

The required cross-section of cylinder is the effective horse-power (150) divided by the effective horse-power per square inch of area .562), or

$$\frac{150}{.562}=267$$

square inches.

The diameter of cylinder is the square root of the quotient of the cylinder area (267) divided by the ratio of the area of a circle to the square of its diameter (.7854), or

$$\sqrt{\frac{267}{.7854}}=18.43$$

inches or $18\frac{1}{2}$ inches to the nearest quarter-inch.

The stroke is twice the diameter (18.5), or $2\times 18.5=37$ inches.

The fraction of clearance is the quotient of the equivalent length of clearance (1.1875) divided by the stroke (37), or

$$\frac{1.1875}{37}=.0321, \text{ or } 3\tfrac{1}{4}$$

per cent. to the nearest quarter per cent.

The dimensions of cylinder just calculated are not exact, but having found the fraction of clearance near enough for practical purposes, the proper corrections can be applied.

The real ratio of expansion is the sum of unity (1) and the fraction of clearance (.0325), divided by the sum of the apparent cut-off (.25) and the fraction of clearance (.0325), or

$$\frac{1+.0325}{.25+.0325}=3.655.$$

The mean pressure for stroke increased by clearance, corrected for back-pressure, uncorrected for cushion, is the sum of the mean pressure up to cut-off (98.75) and the product of the pressure at cut-off (97.5) by the hyperbolic logarithm of the real ratio of expansion (1.2961), divided by the real ratio of expansion (3.655), and diminished by the back-pressure (17.5), or

$$\frac{98.75+97.5\times 1.2961}{3.655}-17.5=44.7$$

pounds per square inch.

The mean pressure, corrected for back-pressure for the stroke, clearance excluded, is the mean pressure, corrected for back-pressure for the stroke and clearance (44.7), diminished by the fraction of clearance (.0325) multiplied by the difference between the initial pressure (100) and the mean pressure corrected for back-pressure, for the stroke and clearance (44.7), or

$$44.7-.0325\times(100-44.7)=42.9$$

pounds per square inch.

The final cushion pressure is the product of the pressure at point of exhaust closure (17.5) by the ratio of compression (3.655), or

$$17.5\times 3.655=64$$

pounds per square inch.

The mean absolute cushion pressure is the final cushion pressure (64) multiplied by the quotient of the hyperbolic logarithm of the ratio of compression (1.2961) divided by the ratio of compression less unity (2.655), or

$$64\times\frac{1.2961}{2.655}=31.2$$

pounds per square inch.

The mean pressure throughout the stroke corrected for back-pressure, clearance and cushion, is the mean pressure corrected for back-pressure and clearance (42.9) diminished by the continued product of the fraction of clearance (.0325), the ratio of compression less unity (2.655), and the difference between the mean absolute cushion pressure (31.2) and the mean back-pressure (17.5), or

$$42.9-.0325\times 2.655\times(31.2-17.5)=41.7$$

pounds per square inch.

The probable mean effective pressure is 95 per cent. of the above pressure (41.7), or

$$.95\times 41.7=39.6$$

pounds per square inch.

The effective horse-power for each square inch of effective piston area is the product of the mean effective pressure (39.6) and the piston speed (450) divided by the foot-pounds per minute in a horse-power (33,000), or

$$\frac{39.6\times 450}{33{,}000}=.54.$$

The effective cross-section of cylinder is the quotient of the given horse-power (150) divided by the horse-power per square inch of effective piston area (.54), or

$$\frac{150}{.54}=277.8$$

square inches.

The actual cross-section of the cylinder is larger than the effective cross-section, since the piston rod reduces the area of the piston on one side. The effective area of a piston is one-half the difference between twice the actual area of the piston and the area of the piston rod; hence the actual area of the cylinder is the quotient of twice the effective area (277.8) divided by 2, less the square of the ratio of piston-rod diameter to actual diameter of cylinder

$$(.018\times\sqrt{100}), \text{ or}$$

$$\frac{2\times 277.8}{2-(.018\times 10)^2}=282.2,$$

square inches.

The actual diameter of the cylinder is the square root of the quotient of the actual area divided by the ratio of the area of a circle to the square of its diameter (.7854), or

$$\sqrt{\frac{282.2}{.7854}}=18.96$$

inches, or 19 inches to the nearest quarter inch.

The stroke is twice the diameter (19), or

$$2\times 19=38 \text{ inches.}$$

The diameter of piston rod is the continued product of .018, the square root of the initial pressure (100), and the diameter of the cylinder (19), or

$$.018\times 10\times 19=3.42$$

inches, or $3\frac{7}{8}$ inches, to the nearest sixteenth of an inch.

Some slight corrections are necessary, on account of the changes from calculated values made in diameters of cylinder and piston rod.

The actual cross-section of the cylinder is .7854 times the square of the diameter (19), or

$$.7854\times(19)^2=283.5$$

square inches.

Similarly the cross-section of the piston rod is

$$.7854\times(3.4375)^2=9.3$$

square inches.

The effective cross-section of the cylinder is half the difference between twice the actual cross-section of the cylinder (283.5) and the cross-section of the piston-rod (9.3), or

$$\frac{2\times 283.5-9.3}{2}=278.9$$

square inches.

The effective horse-power is the continued product of the effective pressure (39.6), the effective piston area (278.9) and the piston speed per minute (450), divided by the foot pounds per minute in a horse-power, or

$$\frac{39.6\times 278.9\times 450}{33000}=150.6.$$

In order to calculate the steam consumption, it will be necessary to determine the volume of cylinder, clearance space, and some other particulars.

The clearance at each end in equivalent length of cylinder is the product of the per cent. of clearance ($3\frac{1}{4}$) and stroke (38) divided by 100, or

$$\frac{3.25\times 38}{100}=1.24$$

inches.

The average volume of clearance at each end of cylinder is the product of the equivalent length of clearance (1.24), and the effective piston area (278.9), divided by 1728, or

$$\frac{1.24\times 278.9}{1728}=.199$$

cubic foot.

Hence, at each stroke of the piston, .199 cubic foot of steam at final cushion pressure (64) is saved.

The average displacement per stroke up to $\frac{95}{100}$ of the stroke is the product of the effective piston area (278.9), the stroke (38) and $\frac{95}{100}$ divided by 1728 and increased by the volume of clearance (.199), or

$$\frac{.95\times 278.9\times 38}{1728}+.199=6.026$$

cubic feet.

The number of strokes per hour is the continued product of the piston speed per minute (450), 12 and 60, divided by the stroke (38), or

$$\frac{450\times 12\times 60}{38}=8526.$$

The absolute pressure of the steam at $\frac{95}{100}$ of the stroke is the quotient of the apparent cut-off ($\frac{1}{4}$) increased by the fraction of clearance (0.0325) and $\frac{95}{100}$ increased by the fraction of clearance (.0325), multiplied by the pressure at point of cut-off (97.5), or

$$97.5\times\frac{.25+.0325}{.95+.0325}=28.1$$

pounds per square inch.

The weight of steam used hourly, as calculated by piston displacement (commonly called steam accounted for or measured by the indicator), is the product of the number of strokes per hour (8526) by the difference between the products of the piston displacement per stroke (6.026) by the weight in pounds of a cubic foot of steam at 28.1 pounds pressure (.06978), and the clearance volume (.199) multiplied by the weight of a cubic foot of steam at a pressure of 64 pounds (.1513), or

$$8526\times(6.026\times.06978-.199\times.1513)=3328 \text{ pounds.}$$

To this must be added the steam condensed, viz.:

1. The steam condensed for the work of expansion, which is a definite quantity, depending upon the work of expansion.

2. The steam condensed on the internal surfaces of the cylinder, which is assumed to take place at the rate of 15 pounds hourly per square foot of surface.

The work of expansion is, evidently, the work due to the total pressure, and according to the mechanical theory of heat, one British thermal unit is required for the development of 772 foot pounds of work.

The mean total pressure during expansion is the quotient of the hyperbolic logarithm of the real ratio of expansion (1.2961) divided by the real ratio of expansion less unity (2.655), multiplied by the pressure at point of cut-off (97.5), or

$$97.5\times\frac{1.2961}{2.655}=47.6$$

pounds per square inch.

The ratio of the work of expansion to the total mechanical effect per stroke is the product of the total pressure during expansion (47.6) and the apparent ratio of expansion less unity (3), divided by the product of the apparent ratio of expansion (4) and the sum of the mean pressure corrected for clearance and back-pressure (42.9) plus the back-pressure (17.5), or

$$\frac{47.6\times 3}{4\times(42.9+17.5)}=.591$$

The units of heat condensed hourly for the work of expansion are found by multiplying together the mean pressure during stroke corrected for clearance and back-pressure (42.9) plus the back-pressure (17.5), the ratio of the work of expansion to the total mechanical effect per stroke (.591), the effective piston area (278.9), the stroke in feet ($38\div 12$) and the number of strokes per hour (8526), and dividing by the foot-pounds of work corresponding to a British thermal unit (772), or

$$\frac{(42.9+17.5)\times.591\times 278.9\times(38\div 12)\times 8526}{772}=348{,}205$$

The amount of steam condensed hourly for the work of expansion is the quotient of the units of heat expended (348,205) divided by the latent heat of a pound of steam (942) at the terminal pressure (28.1), or

$$\frac{348{,}205}{942}=370$$

pounds.

The thickness of piston is the square root of the diameter of cylinder (19), or

$$\sqrt{19}=4.36, \text{ or}$$

$4\frac{1}{2}$ inches to the nearest half-inch. The internal condensing surface consists of sides of cylinder, two sides of piston, two heads, ports (each supposed to have $1\frac{1}{2}$ times the surface of one cylinder head) and piston-rod.

The surface in sides of cylinder is the continued product of the ratio of the circumference of circle to its diameter (3.1416), the actual diameter of the cylinder (19) divided by 12, and the sum of the stroke (38) the thickness of piston (4.5) and twice the piston clearance at each end ($\frac{5}{16}$) divided by 12, or

$$3.1416\times\tfrac{19}{12}\times\frac{38+4.5+2\times.3125}{12}=17.9$$

square feet.

The surface of cylinder-heads, piston and ports is 7 times the actual cross-section of cylinder (283.5) divided by 144, or

$$\frac{7\times 283.5}{144}=13.8$$

square feet.

The surface of the piston-rod is the continued product of the ratio of the circumference of a circle to its diameter (3.1416), the diameter of the piston-rod ($3\frac{7}{16}$) divided by 12, and the sum of the stroke (38) and the piston clearance at one end ($\frac{5}{16}$) divided by 12, or

$$3.1416\times\frac{3.4375}{12}\times\frac{38+.3125}{12}=2.8$$

square feet.

The total internal surface is the sum of the foregoing, or

$$17.9+13.8+2.8=34.5$$

square feet.

The condensation hourly is 15 times the condensing surface (34.5), or

$$15\times 34.5=518$$

pounds.

The total amount of steam used hourly is the sum of the steam accounted for by the indicator (3328), the steam condensed for work (370) and the steam condensed by the internal surfaces of cylinder (518), or

$$3328+370+518=4216$$

pounds.

Dividing the last quantity by the effective horse-power (150.6), it is found that the probable consumption of steam hourly per effective horse-power, taking account of all losses, is

$$\frac{4216}{150.6} = 28$$

pounds.

Before considering means of reducing this consumption, the results for the different points of cut-off assumed will be presented in tabular form, together with the general formulas used in making the calculations.

Herrick's Steam Pump Governor.

The advantages of a reliable steam pump governor, under many conditions, are well understood by those familiar with the management of steam plants, and scarcely need to be mentioned to our readers. They are constantly coming into more general use for controlling the pumps used for returning the water of condensation from heating pipes, cylinder jackets, etc., and in many places where it is especially desirable to maintain a very uniform water level, or a steady flow of water through a feed-water heater, which last, of course, conduces to the economy of the heater.

The governor which we illustrate herewith possesses some very good points in respect of simplicity and absence of parts liable to be deranged, or, by creating friction, prevent the prompt action of the governor.

Its construction is made plain by the sectional view, Fig. 1. Water enters through the lower pipe, designated "water," and rises to a height level with the water in the boiler, and sustains the float *a*, which is a hollow sphere of copper. To this float is attached the stem *s*, to the top of which is attached the valve *v*. Steam is admitted from the boiler through two pipes, *A* and *P*, so that the pressure above and below the valve is equalized. The valve is cylindrical, and has grooves turned on it for water packing, so that friction is reduced to a minimum, and, the valve being balanced, there is nothing to prevent the float from keeping it at a uniform height above the water line, within the limits of its movement. The valve is made hollow to the bottom, and the steam supplied to the pump flows through the openings shown in the valve into the annular passage *c*, and to the pump through the pipe, as shown. It will thus be seen that the supply of steam to the pump depends directly upon the height of water in the boiler (steam pressure remaining the same), without the intervention of levers, springs, stuffing-boxes, or anything likely to cause a failure to act.

Fig. 2 is a rough sketch showing the manner of connecting it to the boiler and pump, and needs no explanation.

The valve, after a short time, acquires the black polish peculiar to cast-iron surfaces moving to steam, and there is no tendency to rust, and no lubrication is required other than that furnished by the water and steam. The governor is twelve inches in height and eight inches in diameter. It is made by Barton, Herrick & Barton, Syracuse, N. Y.

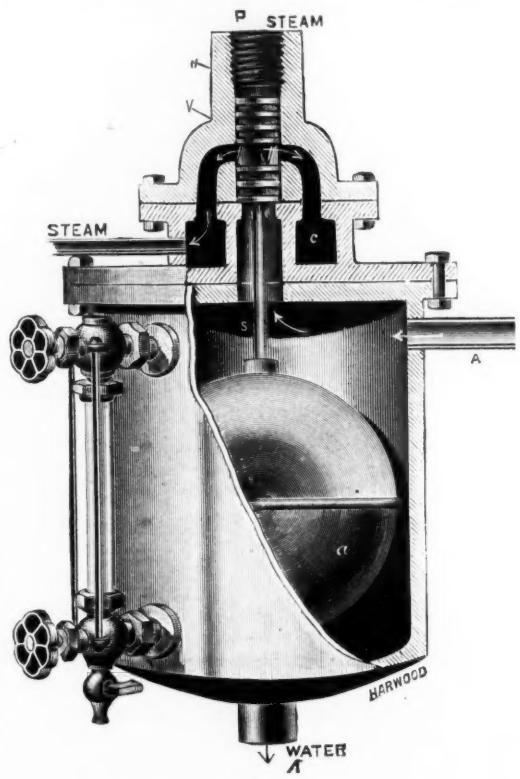
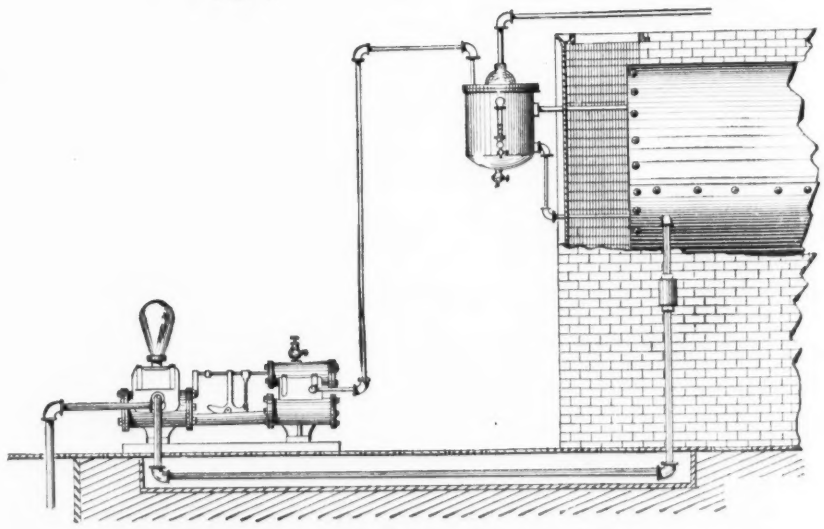


FIG. 1.



HERRICK'S STEAM PUMP GOVERNOR.—FIG. 2.

What is said to be the largest casting ever made in this country, was cast by the Bethlehem Iron Works, at Bethlehem, Pa., May 10. It is to be used in building the plant for the new gun steel works. One hundred and twenty-four tons of metal were poured into the mould, and it is believed to have been successful, though several weeks' time will be required for it to cool sufficiently to determine definitely.

The recent cable dispatch announcing a serious collision May 13th on the Moscow and Kursk Railway in Russia, by which a number of people were killed and injured, seems almost incredible if the Russian railways are managed in the manner indicated in the following article, which we quote from *Engineering*:

In Russia the Minister of Railways regulates the working of the lines to the smallest detail, even in the case of those in the hands of public companies, and not belonging to the State. No innovation can be made without his sanction, and if, for instance, a railway were to order the station masters to wear white caps instead of red, or to only allow the passengers at the buffet stations twenty-nine minutes instead of thirty, the directors would be looked upon as conspirators against the State, and officials armed with the fullest autocratic powers would start off from St. Petersburg to suppress the alteration at a stroke. All reforms, therefore, can only proceed from the Ministry of Railways, which is now engaged on the weighty question as to whether the speed of mail trains in the Russian empire cannot be increased from its present average rate, including stoppages, of 20 miles an hour to 23 miles. This will not strike the English reader as a very daring innovation, but it has consumed the energies of a special commission some weeks, and is likely to do so several weeks longer. On some lines the speed of the mail trains does not average more than 16 miles an hour, after which it will not be surprising to learn that the speed of the ordinary passenger trains on certain lines does not exceed 12. On the best line in Russia, between St. Petersburg and Moscow, the speed of the ordinary passenger train is not more than 15 miles an hour. So numerous and long are the stoppages that the energetic passenger has not only plenty of time to feed, but even to take a walk in the country now and again. The fastest train in Russia is the courier train between St. Petersburg and Moscow, which travels, including stoppages, at about 28 miles an hour. This carries no mails, and consists only of a few first-class carriages. As for the slowest, examples can be found on one or two branch lines of a train only going 10 miles an hour, and even then regularly arriving late. On the Tsaritzin-Don Railway there used to be a tradition that two express trains had once collided without doing each other any harm. In general, the speed of trains in Russia is extremely slow, the halts at the stations far too long, and the trains too few and too heavy for the traffic. Instead of trains of twenty carriages, drawn by two locomotives, running with the mails once a day on the main lines, it would be far better to have two trains of ten carriages apiece running night and morning. Such a reform, however, would be too sweeping. For the moment, the whole spirit of innovation at the Ministry of Railways is concentrated upon raising the speed of the mail trains from 20 to 23 miles an hour, and no further reform can be expected this season.

LETTERS FROM PRACTICAL MEN.

"The Spiral Gear Wheel."

Editor American Machinist:

In your paper of May 19, Mr. George B. Grant has an article on "The Spiral Gear Wheel," in which he shows very clearly the principles which govern its proper construction and action. Although this form of gearing has not been generally adopted by tool builders, it has been used for a long time with great success in the Sellers planing machine, and its peculiar advantages there shown have more recently led to its adoption in a large number of other tools. It is not too much, I think, to say that, until within the last three or four years, Wm. Sellers & Co. were practically alone in the use of spiral gearing, and their experience has taught them to appreciate its value where an absolutely smooth and gliding motion is desired. In their planing machine it has also the advantage of giving greater strength than can be attained by any other form of gearing, because there are always several teeth in contact at once, and furthermore the shape of the teeth there used is not of such vital importance to their proper action as it is with straight gearing. A spiral pinion and rack will engage, if the teeth are badly formed, at the most prominent part of their surfaces, and, unlike any other form of gearing, the teeth will run properly at first, and wear so as to increase the surface contact and perfect the shape.

These pinions have always been cut in a lathe, and originally, the shape of the teeth was approximated as near as could be by a side tool fitted to a templet. It became necessary, however, when spiral pinions began to be used with spur wheels, to form their teeth more perfectly than had ever been done before, and, to accomplish this purpose, a tool the shape of the rack tooth was fed up through the pinion at the proper angle, forming the shape required.

This was done by Wm. Sellers & Co. as early as July, 1883, more than two years before Mr. Beale invented essentially the same process, and it is still our most approved method of cutting spiral pinions. The spiral pinions used in our experiments on the transmission of power by gearing were cut in this way, and their contact was as perfect as could be desired. The teeth of the spur wheel with which they engaged were polished in the middle of their faces for perhaps one-third of their width, showing clearly a greater intensity of pressure in the center, shading off both ways, and demonstrating in a practical way the nature of the contact as described by Mr. Grant.

I do not question at all the originality of Mr. Beale's discovery, but it is nevertheless a fact that the process which he proposed in September, 1885, had been in use by William Sellers & Co. since July, 1883, and that it was also original with us at that time.

WILFRED LEWIS.

Philadelphia, Pa.

Binary and Decimal Fractions.

Editor American Machinist:

I send you herewith a print of a table which I think will be of interest to the readers of your valuable paper, as an improvement over the common arrangement of 64ths and decimal equivalents found in Brown & Sharpe's catalogue, and elsewhere. For finding the decimal corresponding to any 64th, the Brown & Sharpe arrangement is all that could be desired, but to find the equivalent or nearest 64th corresponding to a decimal, often requires looking through all four parts of the table. In the present table once running over settles it. It allows the use of larger figures in printing the 64ths, an arrangement which may be applied with advantage to many columns of fractions. It also gives a direct comparison between any 64th and the next greater or smaller. A column of 8ths could be made if desired, but they are very readily found at 16ths.

BINARY AND DECIMAL FRACTIONS.

$\frac{1}{64}$	=.015625	$\frac{33}{64}$	=.515625
$\frac{1}{32}$	=.03125	$\frac{17}{32}$	=.53125
$\frac{3}{64}$	=.046875	$\frac{35}{64}$	=.546875
$\frac{1}{16}$	=.0625	$\frac{9}{16}$	=.5625
$\frac{5}{64}$	=.078125	$\frac{37}{64}$	=.578125
$\frac{3}{32}$	=.09375	$\frac{19}{32}$	=.59375
$\frac{7}{64}$	=.109375	$\frac{39}{64}$	=.609375
$\frac{1}{8}$	=.125	$\frac{5}{8}$	=.625
$\frac{9}{64}$	=.140625	$\frac{41}{64}$	=.640625
$\frac{5}{32}$	=.15625	$\frac{21}{32}$	=.65625
$\frac{11}{64}$	=.171875	$\frac{43}{64}$	=.671875
$\frac{3}{16}$	=.1875	$\frac{11}{16}$	=.6875
$\frac{13}{64}$	=.203125	$\frac{45}{64}$	=.703125
$\frac{7}{32}$	=.21875	$\frac{23}{32}$	=.71875
$\frac{15}{64}$	=.234375	$\frac{47}{64}$	=.734375
$\frac{1}{4}$	=.25	$\frac{3}{4}$	=.75
$\frac{17}{64}$	=.265625	$\frac{49}{64}$	=.765625
$\frac{9}{32}$	=.28125	$\frac{25}{32}$	=.78125
$\frac{19}{64}$	=.296875	$\frac{51}{64}$	=.796875
$\frac{5}{16}$	=.3125	$\frac{13}{16}$	=.8125
$\frac{21}{64}$	=.328125	$\frac{53}{64}$	=.828125
$\frac{11}{32}$	=.34375	$\frac{27}{32}$	=.84375
$\frac{23}{64}$	=.359375	$\frac{55}{64}$	=.859375
$\frac{3}{8}$	=.375	$\frac{7}{8}$	=.875
$\frac{25}{64}$	=.390625	$\frac{57}{64}$	=.890625
$\frac{13}{32}$	=.40625	$\frac{29}{32}$	=.90625
$\frac{27}{64}$	=.421875	$\frac{59}{64}$	=.921875
$\frac{7}{16}$	=.4375	$\frac{15}{16}$	=.9375
$\frac{29}{64}$	=.453125	$\frac{61}{64}$	=.953125
$\frac{15}{32}$	=.46875	$\frac{31}{32}$	=.96875
$\frac{31}{64}$	=.484375	$\frac{63}{64}$	=.984375
$\frac{1}{2}$	=.5	1	=1.000000

JOHN C. BLEY.

Chicago, Ill.

The Iron Column at Delhi, India.

Editor American Machinist:

The iron column or shaft to which your correspondent alludes (Query 259, May 19), has been known to Europeans for a great many years. Ten or twenty years ago it was examined by an English engineer, who seemed to be an expert in the matter, and the result of his examination and speculations, together with an engraving from a photograph, was published I think, either in the *Engineer* or the *Illustrated News* (London).

The photograph represents the column as a neatly tapered shaft, standing in front of the door of the temple. The sizes I do not now remember, but my recollection is that they were something less than as stated by Mr. Carter Harrison, the length of the part in the ground being unknown. The tradition is that it was made to the order of one of their kings or priests, or something, and placed in its present position as a pin, to hold the earth firmly upon the back of the turtle who carried it.

This shaft was consequently the first *terrapin*, and by a natural corruption of language the term terrapin has been applied to the turtle himself.

The faithfulness with which the contract was carried out is shown in the fact that the earth about Delhi remains where it was, unshaken by earthquakes—which were supposed to be the gambols of the festive tortoise.

The metal of the column is undoubtedly wrought-iron, made direct from the ore, in charcoal fires in the manner and with the rude tools, as practiced by that ancient people for thousands of years. This forge iron being produced in small pieces, the wonder was how they could have been welded together. Wrought-iron shafts are made at the present day by piling and welding small billets, until the required size and length is attained; but this is done by the use of furnaces, and power blast, and steam or power hammers, and even then the welding is by no means perfect.

It was quite certain that men with sledges could not get near enough to such a mass of hot iron as this would be when welded, to do any good, and the theory has been, I think, that this shaft was hammered up by the use of battering rams of timber, slung by ropes and fitted with iron heads.

It is very likely that the welding was very imperfectly done, and, as modern science has shown that the turtle is not there at all, the column has not had its strength very severely tested.

This column is, to my mind, an impressive monument; not to the king or priest who caused its fabrication, but to the unknown men who, through toil and sweat and pain, and amid smothering gas and blistering fire, and under a scorching sun, were our pioneers in the working of iron and metals, and the cumulative results of whose labors for thousands of years we now have all about us.

William H. Harrison.

Braintree, Mass.

Priming in Steam Boilers.

Editor American Machinist:

Writing on the subject of priming, Mr. Benson, in a recent number of the American Machinist, asks for a remedy for priming which shall be safe. To this it is difficult, if not impossible, to give a satisfactory reply to suit ordinary present practice. Grease is well known to be a remedy, but, unless in the case of mineral oils, is to be avoided, and I am not in a position to state positively that mineral oils are invariably safe to use, though undoubtedly they do serve to prevent hard incrustation, and I have myself seen the interior of a boiler which was completely covered with one of the dark, colored cylinder oils, and yet which showed no trace of bad results therefrom. The oil was thick upon the longitudinal stays, and could be ignited by a lamp, and burned freely. It appeared to be in no way changed by its passage through the engine whence it had come via the hot well. The oil showed its presence within the boiler by first exuding upon the front end plate at each of the rivets of the gusset stay angle irons. Though there was no trace of steam leakage at these rivets, the oil seemed to exude freely, so penetrating did it appear to be.

Priming is variously caused. When, by evaporation, the water in a boiler becomes thickened or dirty, the escaping bubbles of steam are large, and their envelope, being thick and viscid, they burst with less readiness than pure water bubbles, and portions of the envelope are thrown upwards, and, becoming entrained with the steam, are carried away by it as priming. Frequently, too, certain of the lime salts separate from the water, and float upon the surface, giving rise to similar results from the local uprush of steam.

New boilers are usually credited with special priming qualities. Very probably this is so, but due, not to any special quality in the newness, so much as to the rapid ebullition from clean non-incrusted plates. A too small water surface will cause priming even with pure water; especially when there is a sudden heavy demand for steam, which causes a drop of pressure with a corresponding outburst of steam from the then superheated water to supply its place. Hence, priming may take place when a large slow-running engine draws steam from a small boiler.

Again, the use of excessive quantities of boiler composition is a fruitful source of priming, a sudden injection of soda being frequently sufficient to cause equally sudden priming. This is because the soda causes the separation of the lime salts held in the water, and these, forming a film on the surface, give rise to priming as above described. It appears, therefore, that, apart from the question of water area and steam capacity, the only real cure for priming is to use clean water, and that, before entering a steam boiler, water should be purified. No English boiler insurance company has dealt with this question in a thorough manner, though individually, many of their engineers have a good knowledge of the question.

Hard water, or water containing in solution the salts of lime and magnesia, is of two varieties, the permanently and the temporarily hard. The sulphates, chlorides and nitrates of lime and magnesia dissolve freely in water, and are not precipitated by open air boiling. On the other hand the carbonates are only soluble in water which contains also free carbonic acid gas ($C O_2$) in solution, and as this is driven off by boiling, the dissolved carbonates are precipitated also. Hence, when caustic soda (NaO) is introduced to such a water, it at once combines with the carbonic acid gas, and the lime salts become insoluble, and may be filtered out, or allowed time to deposit by gravity, as already described in a recent article.

Apart from the dangers already referred to as arising from the admission of grease, there are other evils, chief amongst which is the liability of many greases to decompose with the formation of fatty acids, which corrode the plates of the boiler, as well as form insoluble soaps of lime which may adhere to the furnace plates and cause serious injury or even explosion.

Thus it is that the cure of priming is not easy or safe, if possible, apart from the use of water purification outside and independent of the boiler.

W. H. Booth.

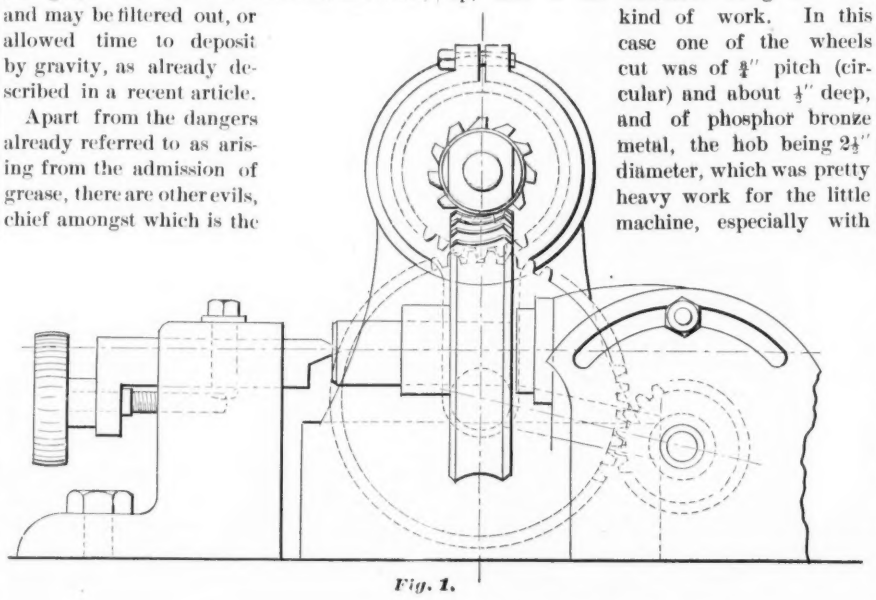


Fig. 1.

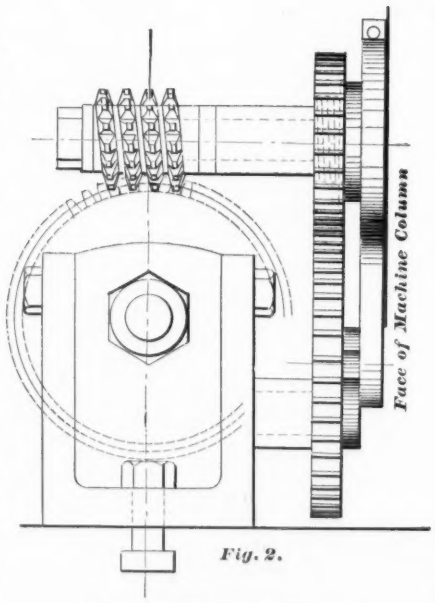


Fig. 2.

Hobbing Worm Wheels.

Hobbing Worm Wheels.

Editor American Machinist:

I recently had a number of worm wheels to make, and being desirous of doing a better job than is usually the result when allowing the hob to turn the wheel as well as do the cutting, I set about devising something to "make the wheels go round" while finishing with the hob, which resulted in the rig shown in the accompanying sketch. To get this up I had to make three gears, 48, 36 and 30 teeth, and the connecting arms as shown. The large, or intermediate gear, is a screw gear belonging to the 20″ inch Putnam lathe.

As will be seen in the sketch, the index-plate, bevel-gears, dust-cap, etc., were all removed from the universal head to make room to put on the gear and the connecting arm. It will also be seen that the machine is a Garvin Universal.

The 48 tooth gear is screwed on to the end of the spindle, and for cutting the 25 tooth wheel use the 30 tooth gear on the worm shaft of the spiral head, and for cutting 30 tooth wheel, use 36 tooth gear. These give the right speed to the wheels for the number of teeth mentioned.

The arm connecting the intermediate gear with the spindle has the stud for the gear forged on it, and extends through the gear far enough to take the arm reaching to the worm shaft of the spiral head, thus holding the gears in proper mesh while feeding the work up to the cutter.

This is not an expensive attachment to get up, and is an excellent thing for this kind of work. In this case one of the wheels cut was of $\frac{3}{4}$″ pitch (circular) and about $\frac{1}{3}$″ deep, and of phosphor bronze metal, the hob being $2\frac{1}{2}$″ diameter, which was pretty heavy work for the little machine, especially with the cutter so far out from the end of the spindle; but under these unfavorable conditions we did a very satisfactory job.

This I give you for the benefit of the craft if you think it worth the trouble of publishing. I have visited quite a number of shops, and read the American Machinist nearly ever since it was started, but never saw anything of the kind before, therefore I believe it is new, so far as applied to the universal milling machine.

Geo. H. Frizzell.

Chicago, Ill.

Practical Details of Punch Work.

By B. F. Spalding.

The "horseshoe" is a name applied to a cutting-off tool used in the punch press for rounding the ends of flat iron. The punch, or upper shear, used with this die is simply a cylindrical piece of steel, with a shank of such size as can be conveniently fastened in the punch clamp of the press slide, and the die is made by welding a piece of steel shaped like the letter U, on a flat piece of iron, or, as is sometimes preferable, it may be made by cutting an impression of that shape in a piece of steel, which is of convenient form to be held in the die holder. This tool will cut off flat bars, and leave one end of the pieces round, and the other end will have the semi-circle cut out of it. This tool is very useful on some kinds of work, but on most of the pieces which are made round on the ends, the work can be done nearly twice as fast, and very often more than twice as fast, by using what is known as a double rounding tool.

There are two kinds of these. One of them rounds both ends of the same piece, and the other rounds one end of each of two pieces, which it separates by the operation. The use of the first is limited to pieces of such length as can be conveniently compassed by the length of the die, while the other can be used to round and separate pieces of any length. The first is of special utility for pieces of the particular length for which it is designed, and the last is of general use. I met with one recently which was made some twenty years ago, but as I had never seen one like it before, it was new to me, and may be to others. It worked very well. It was made for pieces about 4″ long and $1\frac{1}{4}$″ wide. It cut these off from a bar of $1\frac{1}{4}$″ × $\frac{1}{16}$″, rounded both ends and punched two holes at the same time, making a piece at one blow, of the shape shown in the full lines of Fig. 1 (page 7).

The lower die was a steel block of the shape of the full lines of the figure, and had the two holes in it, as shown. The upper die had the semi-circular cutters, fastened by half-inch bolts on the ends and shoulders, on which they rested, to relieve the strain of cutting from the bolts. The short punches were fastened into it by set screws, as shown by the dotted lines of the figure. The "pull-off" for releasing the piece from the grip of the punches and cutters of the upper die, was fastened across between the two holes on the lower die, and the piece, after being cut, remained on the die under the "pull-off" until it was pushed off as the bar was shoved along to cut off the next piece. The pieces punched out of the holes dropped through the lower die, and it was probably for the facility of getting rid of the punchings that the die was made with the punches in the upper die. It will be noticed that there is a good chance for the work to stick between the punch and the cutter, and that it is not very convenient to get a "take-off" in there.

I have seen a die used in a watch factory for punching out the second hand of watches, in which a spring from below raised the hand out from the top of the die after it was punched. There was a little spindle projecting from the pivotal center of these hands, and it was for the purpose of bringing this spindle into the center of the enlargement that a movable guide was held up in the lower die by the spring. This arrangement has also been tried in making washers at one blow, the spring being stiff enough to bear the strain of punching out the center hole in the washer, and when it was released by the rise of the punch, after the washer had been cut and forced down into the die, it threw the washer out of the die and regained its place. If there had been any serious difficulty in taking off the pieces shown in Fig. 1, there could have been some similar device used to overcome it.

It may be of interest to mention that the second hands were forged by laying a bit of annealed steel wire over a hole of the right size to form the spindle, which was made in the lower die of a drop. This was struck a blow which flattened the wire and drove the spindle into the hole. From the pieces thus formed the second hands were punched.

A top view of the form of double rounding die which is best adapted for general use on varying lengths of similar size is shown in Fig. 2.

The punch is milled out in shape to fit the die. It will be seen that a little stock is wasted at every cut of the size cut out between the two pieces. It is good economy to make this amount as little as possible. It must be something, for the punch must have some thickness, to prevent it from cracking in the process of hardening, and from breaking in use. For any size less than 1″ it will be strong enough if $\frac{3}{16}$ of an inch is left to cut iron, but $\frac{1}{4}$″ is not too much if the die is to be used for cutting steel. Probably there will be little advantage in cutting steel of more than $\frac{50}{100}$ of one per cent. carbon with a tool of this description, on account of the risk of breaking. The tool for cutting iron $1\frac{1}{2}$″ wide can be safely left $\frac{1}{4}$″ thick. The 2″ should be $\frac{5}{16}$″, and if the one for cutting $2\frac{1}{2}$″ is made $\frac{3}{8}$″ thick at the thinnest place it will not fail on account of being too thin. I have had no experience with these tools larger than for $2\frac{1}{2}$″, but there is nothing to prevent their doing well, if made right, of any size that may be required. The circles should be of a little larger diameter than the width of the iron which is to be cut.

For sizes larger than 2″ the bed plate shown in Fig. 3 can be used, and the dies for

different sizes of iron can be easily made and fastened on in their places, as shown in Fig. 4. The tongues *A A*, Fig. 3, serve to support the dies to a great extent. The dies are fastened by bolts that come up from below through the slotted holes which are cored through at *B B*. This must be done, of course, before the plate is fastened to the punch bed. The set screws behind keep the dies from crowding back.

PUNCHING STEEL PLATE.

On Eighth avenue, one day, I heard musketry firing, and went down there and examined places on the east side, where the balls had struck, and noticed particularly the perforations they had made in the window glass. The balls which had been fired were conical, and it was easy to distinguish the holes which had been made by those which had turned in their flight and struck sidewise, from those that had not, by the difference in the shapes of the holes they had made. I do not remember to have seen a glass that was cracked by any ball that went through fair. These made round and comparatively smooth, clean holes. This, and the effects of stones thrown against windows, go to show that the amount of cracking around the hole is in proportion to the velocity of the projectile. The bullets went through before the glass had a chance to crack. If the point of a cane should be pressed against a window pane, and sufficient pressure brought to bear upon it to force it through, the cracks would radiate all around it, and extend to the edges, before it appeared on the other side. Applying the lessons to be learned from these phenomena to the punching of steel plate, we would infer that the conditions favorable to the production of cracks in punching holes in steel plates are farther removed in proportion as the velocity of the motion is increased. The quicker the stroke, the fewer the cracks.

THE DIE TO BE LARGER THAN THE PUNCH.

If we thrust with a cane in the air, and again in the water, we shall notice but little difference in the resistance, for we are not quick enough to get up an appreciable resistance in either; but if we fire a steel bullet into the water, although it is no bigger across, or not of greater normal section than the point of the cane, we find that its rapid motion is at once impeded by the resistance; and we suppose that the cause of this is that a cone of compressed water has formed before it, on the apex of which it rests, while the semi-spheroidal base expands indefinitely ahead. This is impenetrable to the ball at the high speed. It is compressed most at the apex, and offers increasing resistance as the cone increases at the base. If we carry this idea into practice in punching steel, it will lead to making the die of larger diameter than the punch, as there is a cone of compression formed on the end of a punch in the material subjected to its operation, and the less this cone is opposed and shaved off by the die, the less dense is the compression, and the less the consequent strain tending to rupture the plate. In punching steel plate $\frac{1}{4}''$ thick with a punch $\frac{5}{16}''$ in diameter, I have used a die $\frac{9}{16}''$ in diameter, making the hole $\frac{7}{16}''$ on one side and $\frac{9}{16}''$ on the other; but all of the holes were not smooth, which indicated that the angles allowed for the cone were too obtuse. That some were smooth and others were not, was proof that the shape of the natural formation of the cone varied with the nature of the material, and that the nature of the material was not uniform in the plates which were punched.

It is an opinion into which any one is liable to fall, that if the punch is smaller than the hole in the die there will be a burr carried down all around it. My impression that this was the case came from noticing that when a die had become worn out large, a burr invariably formed around the punch, but found the cause of this in the fact that the die wears out "bell mouthed"—larger at the top than it is a little ways down—and the metal which forms the burr thus receives support from below. When this support is removed by making the hole the largest on the lower side, and the sides straight, there will be no burr formed, provided the size of the hole does not exceed the size of the base of the cone of compression.

Some difficulty was experienced at one time with some steel washers which were to be punched out of $\frac{1}{64}''$ steel, $2\frac{1}{2}''$ in diameter. The hole in the all steel die contracted irregularly in hardening, and was not lapped out. The tools were set by a careful man, but of course the hole was a little marred, and the steel, being tough, showed the defect in a slight, sharp burr. This was not wanted, and the die was ground out, and made $\frac{8}{1000}''$ larger than the punch, and after this was done the washers were punched without burr. Washer dies of all sizes that I have tried, on iron or steel, work better when this allowance is made than when they are worked with close fits. In punching, the general rule is safely given, that fair iron can be punched when the thickness to be punched through does not exceed the diameter of the punch. Practically, fair iron can be punched more profitably than it can be drilled, with ordinary methods, when the thickness of the stock is not more than one and one-half times the diameter of the punch. By the use of special tools this limit may, in some cases, be exceeded.

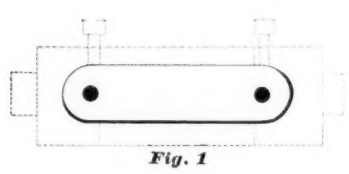


Fig. 1

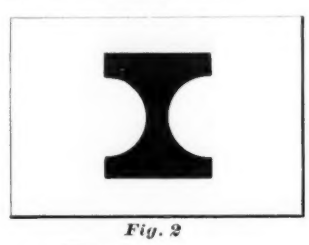


Fig. 2

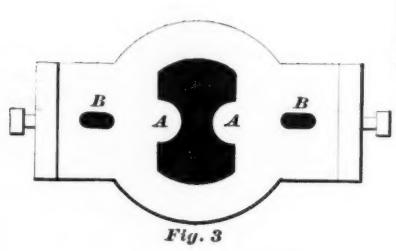


Fig. 3

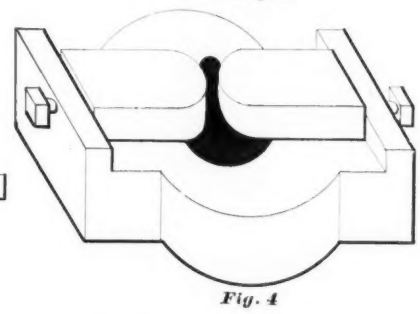


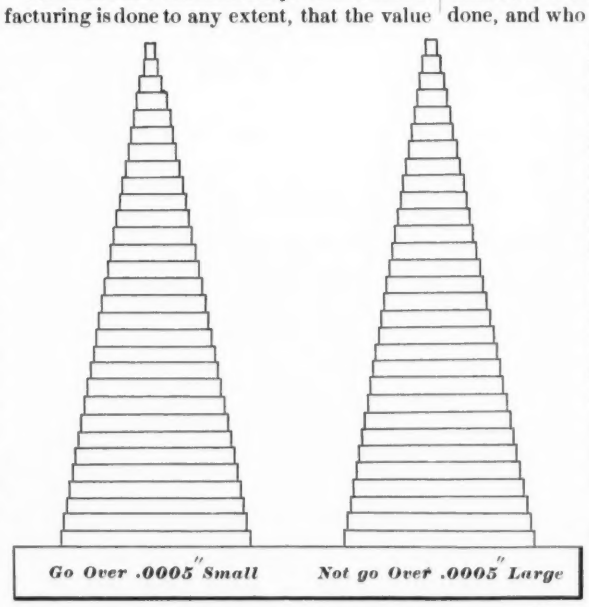
Fig. 4

DETAILS OF PUNCH WORK.

Calipers and Calipering.

BY A. B. LANDIS.

There are few machine shops where manufacturing is done to any extent, that the value of the solid or standard gauge caliper is not known, and where they are not now also used. Their value cannot but be apparent to every practical man, and especially when once used by them. Greater accuracy can be attained by their use than by the spring or jointed caliper, because in the first place they are heavy and strong, and cannot be sprung over the work without readily detecting it; in the second place, they are standard sizes, and no dependence need be placed in the workmen to set calipers accurately to a scale (which no two persons will do alike), consequently they are of great value to make parts interchangeable.



CALIPERS AND CALIPERING.

Owing to these calipers being heavy, many persons fancy they cannot be sprung or injured. The proprietor will perhaps purchase a full line of them, and fancy he has a set of standard measures which will permanently remain so, and be reliable at all times, owing to their firmness, and having hardened and finely ground calipering surfaces, which it might appear will not wear. Having purchased these gauges with a view to securing interchangeable parts in his shop, he sees the necessity of standard reamers for finishing the holes to which work measured by these calipers must fit. To meet this requirement he purchases a measuring instrument, by which he measures these reamers, and keeps them to size. As the size of reamers should be a trifle —say one to two one-thousandths—larger than standard size, it would not do to use the standard caliper for this purpose. He is now fixed for operations, which go along smoothly for a while, when presently the shafts wont enter the holes; what's the trouble? Reamers worn down already? An examination shows them to be all right; the trouble must be in the calipering by forcing the caliper; an examination shows that they go over all right. Then the fault must be in the caliper which has gotten out of size. What! some may say—those hardened surfaces already worn down, and only so short a time in use? No; but the likelihood is that the caliper has had rough usage by some one, either known or unknown to the one who did it. Yet it is done, and who did it or how it was done may never be found out; and there's a big lot of shafts, all to be gone over again. Because standard calipers were used no trouble was anticipated, and the idea of frequently examining them was perhaps not thought of. The matter of examining them by the ordinary method, which is with a vernier caliper (the only instrument on the market to take inside measurements), not being convenient, the most convenient thing was to conclude that of course they are all right, they are standard calipers.

A bad practice in the use of standard calipers is the attempt to pass them over the work while it is running, which, if done, and the work is not down to size yet, is sure to catch, and, if it comes in contact with the tool, or the tool rest, it will force itself over, and if the shaft is sufficiently large it will permanently strain and enlarge it, if not (as I have seen the case already) break it in two.

A caliper thus strained and enlarged can be brought back to the tool room in apparent good condition, and be ready to go out again in this condition on another lot of work, which, of course, will not be right.

A caliper may be brought to the tool room in the other condition—too small—which can be caused by laying it on the shears of the lathe and having it caught between the carriage and head or foot stock, so as to crush it together. Or perhaps the operator made some work too small, and to screen himself (if he is not honest) he may close the caliper, by pening it to suit the work he turned (as I have known a case), and claim that he turned the work to the caliper; thus preparing it to spoil the next lot of work in addition to what he has spoiled.

Now we want a remedy for this trouble that will be simple in its use, and yet very reliable, so that we may be assured of the accuracy of the calipers at all times, and which will enable us to trace any variation from a correct size to its true cause at once, and hold the guilty party responsible; which will cause more care among the men in their use.

I had a great deal of trouble in this direction a few years ago, and I made a test on the limit gauge plan, to be used by the attendant in the tool room as the calipers are returned, which has thoroughly overcome all this difficulty, and has already many times paid its cost. I will describe the arrangement.

I made two step cones (as herewith illustrated) and placed them on a base as shown, commencing at the bottom with the largest size mostly used (in my case 3") down to the smallest, by the regular variation of sizes in use ($\frac{1}{8}''$ or $\frac{1}{16}''$); each of these steps has the size marked on it. They are hardened and ground to accurate size. On the base is marked at the one cone, "Go over .0005", small"; at the other is marked, "Not go over .0005", large," and the sizes of these steps are ground to these measurements; that is, one was one-half thousandth small, and the other one-half thousandth large, thus giving a limit of variation of .001", which would show any error in the caliper either way, amounting to .0005" of an inch, which is close enough for all practical purposes. The cones are loosely mounted on the base, so they can be turned to divide the wear all around them.

Now when calipers are returned to the tool room, the tool attendant first takes them and passes them over the "go over" cone, and then to the "not go over" cone, and so long as the calipers will stand this test they are counted correct, passed to their places, and the check returned to the workman. But as soon as it happens that the calipers will either go over both cones, or go over neither of them, you can demand of the workman a cause; for certain it is that in his hands it received violence or misuse in some way. In such a case the caliper passes to the tool department or shop, is reset and reground to accuracy before any further work is done with it. The change in sizes from wear will be very gradual, and can be detected by the tool attendant and be turned in at the proper time.

It will be seen that by this method all trouble interfering with the work in the shop will be avoided, as well as the annoyance of having some one to inspect the calipers who would have to be expert at it. And the workmen have a reminder that they must use care with them, or they will otherwise be found out.

Some may say, why not harden these calipers all over, and thus avoid this permanent setting? But I prefer them soft (except of course the points) especially where a great many beginners are at work, and others equally (if not more) careless; as I think many of them would be broken, and thus require new calipers to replace them. Whereas by this method it will simply be necessary to adjust them, and grind to size. And again, when such calipers would become too large from wear, they would require annealing and again rehardening.

Suffice to say that this method has worked excellently, and I am satisfied that whoever adopts it will find it satisfactory.

The latest thing we have heard of in the way of a trust is a land trust. The initial steps in the formation of one have been taken at Randolph, Kansas City. All the real estate owners are to unite and pool their land in a combination trust, receiving stock in the company therefor. A tract of land extending over a mile each way from the station is included, embracing over 2,000 acres. We should think this would be a very good town for manufacturers and others who must use land in order to carry on business, to stay away from.

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J. G. A. MEYER, } Associates.
FRED J. MILLER, }

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale. We give no premiums to secure either subscribers or advertisers.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once.*

Subscription.

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NEW YORK, JUNE 9, 1888.

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Manufacture in Tennessee.

There is a good deal of ore and coal in Tennessee, and it may be expected that iron of certain grades can be made there at comparatively low cost; lower, probably, than in Pennsylvania, because the raw material is nearer the points where it is worked up. But when it comes to putting down that iron in New York, or other Northern places of distribution or use, the question of freight has an important bearing. There is, however, a feeling in Tennessee, by no means concealed, that iron manufacture there is to have an important influence on the Northern market; to speak plainly, that the blowing in of Southern furnaces, and the blowing out of Northern furnaces, will, in a measure, go together. We see no occasion to anticipate this, and believe if it were to follow it would be a bad thing for Tennessee. What is needed there is a population of stable character, engaged in a diversity of pursuits—agricultural and mechanical; a population that will practically absorb the iron produced in the State. This point was very aptly made by Mr. Kent at the meeting between the Chamber of Commerce and the citizens of Chattanooga, and the Mechanical Engineers, during the visit of the latter to that city. It is sound common sense, worth any amount of talk about flooding the North with Southern products to the closing up of Northern manufactories; something never likely to happen, and something which, if it did occur, would be about as bad for Tennessee as for Pennsylvania or Massachusetts.

At present, perhaps, three-fourths of the iron produced in Tennessee finds its way North, and there is not undue profit to the furnacemen then. By and by it will be seen that if this iron is used at home considerable money in the way of freights will be saved.

A good deal of stress is laid in Tennessee on cheap labor. If anything permanent is gained in Tennessee by keeping wages low, then the experience there will be different from that of any other part of the world. What manufacturers need in the North is high-priced labor, in the sense that they need workmen who receive and earn good wages, and the needs of Tennessee are in no way different. Any other labor is never cheap, except in name. There can never be prosperity—not even local prosperity—unless workingmen—the great mass of the population of any locality—are able to buy largely of the products of others. To a disinterested observer, the impression is that Tennessee is inclined to depend too much upon natural advantages and cheap labor. The former are easily overrated; the latter is a delusion. Low wages will never bring the kind of population necessary to the development of the resources of any section of this country.

Skilled mechanics are needed in Tennessee, but they must be provided with work at good wages, or they will always be needed. Some of the mechanical work being done there at the present time, by labor not properly skilled—labor gathered from here and there—is not calculated to create a favorable impression; in other instances, where the skill required is less, or where pains have been taken to secure better skill, the impression is different.

While the climate of Tennessee is favorable, in that it reduces the cost of living somewhat, as compared with the colder climate of States further North, this advantage is offset by the fact, plainly discernible, that men do not work as hard or as steadily in the warm as in the colder climate. This is a condition not likely to be changed. It is in the wisdom of nature, and no human law or custom can prevail against it. This is something that must be considered and allowed for in any intelligent comparison of the advantages for manufacture of different sections of this country, embracing, as it does, almost every variety of climate. There is no reason to believe that a mechanic in Tennessee will ever, with the same facilities, be able to produce as much as a mechanic in Massachusetts.

In the foregoing there is no intention to discredit the possibilities of successful manufacture in Tennessee. On the contrary, considerable has already been done there in that direction, and those who think progress has not been rapid, should consider the fact that it is only a few years since a beginning was made, as well as the fact that progress in manufacture is necessarily slow in any part of the country where it is new. There is good reason for satisfaction with what has already been done, and good reason to believe that solid progress will be made in the future. Natural advantages, including a geographical situation that affords opportunity for good business in what is termed the South, are in favor of this. The iron and coal in the hills of Tennessee will slowly but surely find their way to the surface and the fine timber of the country will be worked up at home. But the progress of manufacture will not be such as to endanger the prosperity of other sections of the country. Manufacturing there will grow up just as it does and has done elsewhere, and "booms," if attempted there, will be just as disastrous as they are in the North. The need of a stable producing *and consuming* population will come to be better understood than it is now. When Tennessee becomes a manufacturing State there will be nothing said about the advantages of cheap labor.

Restricting the Number of Apprentices.

The American Medical Association, which recently met in Cincinnati, "greeted with storms of applause" that part of the president's address in which he proposed that measures be taken to cause a diminution in the annual number of medical graduates, and a reduction of the number of medical colleges.

Certain regulations were proposed for those colleges which were not to be abolished, and it was declared that "any college or school, which shall refuse to enter into such an arrangement as may be decided upon by said convention," shall be excluded from all connection with the American Medical Association, and its alumni not recognized as members of the regular profession."

It is a familiar fact that the medical, like most other professions, is considerably overcrowded, and the numerous young graduates turned out every year by the many medical colleges are constantly making it more so, and it is, of course, with the idea of checking this over-crowding, that this action is proposed to be taken.

We do not propose to discuss the propriety or impropriety, justice or injustice of so doing, but we wish to call attention to the fact that this is precisely the same thing as the restriction of the number of apprentices by trades unions, about which some people seem so much exercised. Now it may be wrong for the members of any professional or trade organization to take measures to restrict the number of young men who may be allowed to enter it, or it may be right; as we said above, we are not discussing that question; but what we do pretend to say is that if it is wrong for one it is wrong for the other, and that exactly the same principles are involved, whether the association doing it be composed of doctors, lawyers, merchants, or mechanics.

Moreover there is a proposition quoted above, to boycott all colleges which do not choose to submit to the terms of the association, and yet we find the daily papers generally commenting favorably upon the action of the doctors, notwithstanding that many of these same papers have strongly condemned the same action, when taken by workingmen.

Of course there is much to be said upon both sides of these questions, but we believe nothing is to be gained by such exhibitions of insincerity and lack of fairness on the part of the press. Workingmen easily perceive the injustice of it, and though they be willing to discuss such matters upon their merits, no paper can hope to wield any influence with them, when it shows plainly that what it condemns in one set of men, it upholds in another.

In commenting upon the actions of any organization which affect the rights of the public, the question as to whether the men composing the organization wear broadcloth or blue overalls, ought not to have any weight whatever.

General Mechanics.

MECHANIC—A general mechanic wishes employment; is willing to work at anything.

The above advertisement we clipped from a daily newspaper, where it appeared among hundreds of others, announcing that the various advertisers were willing to perform various kinds of skilled or unskilled labor. But the others all differed from this one in the fact that they specified the particular kind of work which the advertisers considered themselves competent to do, and at which they wished to find employment.

We venture to predict that if but one among all these advertisers received no reply, that one was the "general mechanic." In these days a man who advertises himself as a general mechanic may be set down as being pretty nearly no mechanic at all, except possibly in the sense that an amateur may be considered a mechanic.

Good mechanics, as good mechanics go nowadays, have made a specialty of some particular branch of mechanical work, and have mastered that branch, devoting all their time and talents to that one thing, and the man who claims to be a general mechanic and is "willing to work at any thing," must compete with such men, and will inevitably be beaten.

No man can possibly divide his energies and time between half a dozen or more occupations and in each one, or, for that matter in any one of them, hope to equal in efficiency the men who have made a specialty of that one thing, and employers looking for workmen know this, and give their preference accordingly.

Not only is this true in mechanical pursuits, but it is constantly becoming more and more the tendency in the professions, notably in engineering, law and medicine, and in commerce. And most men who want any kind of service performed, go to a man who makes a specialty of that service, and not to one who professes to know much or little about everything, and our advice to any young man who wishes to be successful, and to have his services allways in demand, is to train himself in some one occupation to the fullest possible extent, and be prepared to compete with all comers in his chosen pursuit. A man who wishes to excel in any given branch of learning does not go to any "Cyclopedia of Universal Knowledge" pretending to cover the whole field of human attainment, and containing $10,000 secrets about how to do everything; but he reads books which relate especially to the one subject which he desires to study, and such books are written by specialists.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(283) R. J. F., Bad River, Wis., asks: Please inform me as to the proper way of adjusting piston rings. Should we break joints or not? Should the opening in rings be set opposite the ports? *A.*—See AMERICAN MACHINIST, page 7, June 11, 1887.

(284) J. Z. H., Kansas City, Mo., asks: Do you think that air can be made to propel a boat by the use of an air pump, forcing a column of water through a pipe through the bottom of a boat? Do you think it is practicable? *A.*—It is possible to do so, but it is not practicable.

(285) W. A. G., Baltimore, Md., writes: I have a small engine 2¼ inch bore, 6 inches stroke, ports ⅝ x ¼ inch. How much power can I obtain from this engine with 60 pounds' boiler pressure, engine to make 125 revolutions per minute? What size boiler will I require, and about how much will it be worth? *A.*—Your engine running at such a slow speed, and cutting off at about one-half stroke, will develop about three-quarter horse-power. Under these conditions you will need a boiler with about 16 square feet of heating surface and about 1 square foot of grate. As to the cost of boiler, get estimates from boiler makers.

(286) R. W. B., Lake Hopatcong, N. J., writes: I have had an argument with a friend in regard to the inventor of the locomotive, and would like you to throw some light on the subject in your next issue. My friend claims that George Stevenson was the inventor of the locomotive; I claim that a man named George or William Murdoch—I am not positive which—was the inventor; that is, he was the man who made the first model locomotive. I am willing to admit that Stevenson has the distinction, and probably was the first to apply steam for the propulsion of carriages successfully, and put the invention to practical use; but, was he the first to discover that steam could be used to propel wheeled vehicles? *A.*—There is considerable doubt on these points, and the credit of first discovery is claimed for various persons and in various countries, but we think the credit should be given to the man who first reduced the matter to practice, or showed how it could be done, and that was Stevenson.

(287) X. W., Canada, asks: 1. Can a fire be hot enough under a boiler to blister it, when the water and boiler are perfectly clean, the boiler being a common horizontal boiler? *A.* Yes. 2. The plain D slide valve of a stationary engine being set to cut off at ¾ stroke, would it be necessary to alter the shape of the valve in any way in order to connect it with a link so that the point of cut-off can be changed as in a locomotive? *A.*—No. 3. Why are the tubes of an upright boiler not injured where they are exposed to the heat above the water line as is the case of a horizontal boiler when the water is too low. *A.*—The ends of the tubes extending above the water level to the upper tube sheet in upright boilers are at times liable to injury by overheating. When they are not injured it is either due to the fact that they are not exposed to such an intense heat as the flues in horizontal boilers are exposed to, or greater care is bestowed upon the former than upon the latter. That the ends of tubes in this class of upright boilers are liable to injury is proved by the fact that many upright boilers are made in which the upper tube sheet is sunk below the water level so as to surround the whole length of tubes by water, and protect them from injury by overheating.

(288) F. E. W., Marquette, Mich., writes: Please give me the best figures you know, and the average figures for pounds of water evaporated per square foot of heating surface from and at 212 degrees; pounds of coal per square foot of grate, and pounds of water per pound of coal for a good locomotive engine. *A.*—Believing that under the present excellent management of the Pennsylvania Railroad Company, the highest economy of fuel could be obtained, we submitted this question to Mr. Theo. N. Ely, General Superintendent of Motive Power, who courteously replied as follows:

The figures we send you are average figures taken during coal and water trials that have at different times been conducted by the Test Department.

JANUARY, 1875.

	Class "C" Locomotive Pass. Pgh. Div.	Class "D" Freight Middle Div.
Coal per mile run	46.5	80 pounds.
Pounds water per pound of coal	6.55	6.22 "

MAY, 1878, LOCOMOTIVE 482, CLASS "D."

Time of run (up from Altoona to Gallitzin) 1 hour and 5 minutes.

Coal consumed	2,650 pounds.
Water evaporated	7,820 "
Average steam pressure	118 "

Temperature, 60 degrees F.

OCTOBER, 1882.

On Pgh. Div. passenger locomotive, class "Ba" with best coal evaporated 6.21 to 6.70 pounds water per pound of coal on average.

JULY, 1883.

In eight round trips trains No. 1 and No. 8 Pgh. Division "Ba" passenger locomotive.

Consumed	84,349 pounds coal.
Evaporated	567,017 " water.
Greatest amount of water per pound coal	7.7
Least " " " " "	6.6

Maintained an average steam pressure of 132 pounds. Temperature of feed water, 65 degrees. Schedule time per round trip, 3 hours, 45 minutes West, 3 hours and 40 minutes East. Distance each way 116.7 miles.

FEBRUARY AND MARCH, 1888, CLASS "R," LOCOMOTIVE 389, FREIGHT.

	14 trips, distance 77 miles.	14 trips, distance 77 miles.
Coal consumed	128 813 lbs.	139.403 lbs.
Water evaporated	879,746 "	880,760 "
Running time,	4h. 37m. per trip.	4h. 24m. per trip.
Steam pressure, average	134 lbs.	136 lbs
Temperature atmosphere.	27 deg.	36 deg.
Temperature of feed	40 deg.	40 deg.

The dimensions of locomotives mentioned above are as follows:

	Total heating surface	Grate area	Cylinder diam.	" stroke	Diam. wheel.	Wt. of loco. in working order
"Ba"	1056.98 sq. ft.	17.6 " "	18"	24"	58"	80,500
"C"	1056.98	17.60	17"	24"	62"	79 100
"D"	1093.22	14.50	18"	22"	56"	84,300
"R"	1731 04	31.10	20"	24"	50"	114,600

Class "C" locomotives have evaporated as much as 8 76 pounds water per pound coal. Class "Ba" locomotives have no better record than 7.70 pounds water per pound coal, which is nearer the average than the above figure for Class "C" locomotives. Class "R" locomotive averages 6.30 pounds water per pound of coal. Few trials have been made with an idea of determining the amount of coal consumed per square foot of heating surface or grate area, or to determine the evaporative efficiency "from and at 212 F," the object in most cases being the comparison of different kinds of coal. 2. Also give similar figures for stationary return tubular boiler. *A.*—With natural draft the rates of combustion vary from 7 to 16 pounds for anthracite coals, and from 12 to 27 pounds for bituminous coals per square foot of grate per hour. The evaporation of water per pound of coal depends somewhat on the rate of combustion; under favorable circumstances, 16.5 pounds of water may be evaporated per pound of coal. 3. What do you consider the proper weight, amount of heating surface, size of fire box and diameter of boiler for a locomotive with cylinder 17, 18, 19 inches diameter. *A.*—We believe that you cannot adopt better proportions of grate and heating surfaces than those given by Mr. T. Ely, the same may be said as to the weights of the engines. The weights of the different classes of locomotives you will also find in the article on Modern Locomotive Construction, AMERICAN MACHINIST, Aug. 8, 1887. These weights closely agree with those given by Mr. T. Ely. The diameter of the boiler depends upon the number of flues. The number of flues is obtained by making the sum of transverse area of the flues equal to about 1-6th of the grate surface.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

See Grant's Gear advt. on back page.

Link-Belting.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link Belt Machinery Co., Chicago and N. Y.

Taper attachment on all lathes Lodge, Davis & Co.

Compound rest on all lathes Lodge, Davis & Co.

Power cross-feed on all lathes Lodge, Davis & Co.

Large hollow spindle on all lathes Lodge, Davis & Co.

Automatic stop on all lathes Lodge, Davis & Co.

See special ads. pages 15 and 16 Lodge, Davis & Co.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Lamb Knitting Machine Co., Chicopee Falls, Mass.

Machine work and pattern making. Anderson Machine Works, Peekskill, N. Y.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

Drop presses, punches and shears. Williams, White & Co., Moline, Ill., manufacturers.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Improved fine tools for mechanics, manf'd by L. S. Starrett, Athol, Mass. Send stamp for full list.

"Swift" Sight-feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.

Davis Key-Seating Machines, kept in stock, by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Burnham's turbine wheel is sold at net price to mill owners. Catalogue free. Address York, Pa.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 120 Liberty st., N. Y.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st., Chicago, Ill.

Ice and Refrigerating Machines, 124 built, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers Frasse & Co., 92 Park Row, N. Y.

Artesian, salt and oil well pumps; sucker rods and deep well supplies; wrought-iron tubing and steam pipe. Hardwicke & Ware, Buffalo, N. Y.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Model engines and castings. Prices $3.75, $4.75 and $5.75. For descriptive circular apply to Montgomery & Co., 105 Fulton street, New York city.

Robertson's damper regulator; no diaphragms, springs or packing; the cheapest good regulator in market. Hine & Robertson, 45 Cortlandt st., N. Y.

Machinists' supplies, brass goods, m'f'rs supplies, polishing materials, all kinds wire, metals, etc., in any quantity. Jordan & Gottfried, 208 Canal st., N.Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N. Y. Send for des'n.

Patent Att'y. R. G. DuBois, 916 F. st., Washington, D. C. Reliable service at reasonable rates. Send for 38-page pamphlet containing list of references.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches; working drawings for the transmission of power by steam, water, air and electricity.

Parties requiring milling machine or screw machine work furnished, in large or small quantities, please write to the manufacturers, E. E. Garvin & Co., 139, 141, 143 Centre st., New York City.

The Dieble Mfg. Co., Philadelphia, Pa., mfrs. of the Challenge emery grinding and polishing machinery, invite correspondence with all needing this class of machinery. Catalogues and prices on application.

Contract work of all kinds executed promptly and on reasonable terms. Parties wishing gray iron castings in large quantities can make money by corresponding with Rawson Mfg. Co., Hornellsville, N. Y.

For the manufacture of
Patented articles in line of machine work;
Specialties in fine light machinery;
Accurate cam cutting,
Address Wardwell S. M. Co., Woonsocket, R. I.

A practical treatise on the steam engine, by Arthur Rigg, essays on the principles involved in design and construction of fixed engines; 312 pages, with 96 plates. 4to, cloth, $10.00. E. & F. N. Spon, 12 Cortlandt st., N. Y.

James D. Cardell & Co., 1900 Passyunk ave., Phila., Pa., boiler makers and sheet iron workers, m'f'rs of coils of wrought-iron pipe, return bends, etc. Address after June 15, Rising Sun Lane and North Penn. R. R. Boiler repairs promptly attended to.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price $2, post paid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

The series of articles by J. G. A. Meyer, on "Practical Drawing," now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including June 2, 1888 issue, 51 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada, at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction," by J. G. A. Meyer. The above series of articles now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 65 articles have thus far appeared up to and including the May 26, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

MANUFACTURES

The Hot Springs, Ark., gas works will be rebuilt.

A flour mill is to be built at Batesville, Ark., by M. McClure.

A "Ball" electric light plant will be established at Fall River, Mass.

The screw factory recently burned at Bessemer, Ala., will be rebuilt.

Coleman & Carley are interested in building an electric light plant at Meridian, Miss.

Joseph Wall will build a foundry at Greenville, Miss.; he will also enlarge his machine shop.

Lodge, Davis & Co., Cincinnati, Ohio, have issued a four-page circular illustrating and describing several new machine tools brought out by them.

The *Lewiston Journal* says there is a general starting up of the idle industrial establishments of Maine.

The Pond Machine Tool Works at Plainfield, N J., are at present crowded with orders, and find it necessary to run some departments night and day.

S. A. Smith, 23 South Canal street, Chicago, Ill., is Western agent for the Brown & Sharpe Mfg. Co., and will keep a stock of their tools and machines on hand.

Reports from many parts of the country show the iron and steel business to be comparatively dull, and reduction of wages seems to be the order of the day.

The valley mill of the Stewart Iron Company, at Sharon, Pa., has closed, throwing 100 men out of employment. Dullness of the iron market caused the shut-down.

A company has been formed to manufacture a wool spinning machine, recently brought out by Mr. Wright, of the Wright Machine Company, Worcester, Mass.

Work has been begun on the new buildings of the Crescent Foundry Company, Allegheny, Pa. The building will be 60 x 120 feet. Employment wil. be given to 50 men.

The Erie City Iron Works, Erie, Pa., have issued an illustrated catalogue of their new automatic cut-off engine. The catalogue is quite complete, and well illustrated.

The Texas Star Mill, Galveston, Tex., has increased its capital stock to $500,000. The company, in addition to making flour, will mill rice, make starch and build grain elevators.

The Virginia Agricultural, Mechanical and Tobacco Exposition will open in Richmond, Va., on Oct. 3, and will close about Nov. 21. Exhibits will include all arts, manufactures, and products of the soil and mine.

The Pond Engineering Company, St. Louis and Kansas City, Mo., has issued a special boiler catalogue, which, in addition to describing the boilers made by them, contains some interesting and instructive matter relating to boilers and boiler material.

The Sterling Emery Wheel Company, 17 Dey street, New York, send us a new illustrated catalogue of their specialties. The catalogue is well illustrated, with cuts of emery wheels, emery grinders, polishing and buffing wheels, walrus wheels, emery paper, etc.

The directors of the Oil City, Pa., Tube Mills have increased the capital stock from $200,000 to $300,000. Among the contracts now being filled by the tube mills is the manufacture of the pipe for a gas company to supply the town of Wapakoneta, Ohio. The gas will be piped from the St. Mary's field, 18 miles distant.

New water works, or the enlargement of existing works are contemplated at Grand Junction, Cal; Leoti, Kan.; Birmingham, Ala.; Whitestone, L. I.; Sidney, Ohio; Baker City, Ore.; Waldboro, Me.; Barrington, R. I.; Lonoke, Ark.; Boothbay, Me.; Abilene, Tex.; St. Peter, Minn.; Little Valley, N. Y.; Monongahela, Pa.

John Tregoning, for the last three years superintendent at the Mather Electric Company's factories in Hartford and Manchester, has resigned, and will move to Lynn, Mass., to take charge of a department for the manufacture of electric welding machinery in the factory of the Thomson-Houston Company.—*The Commercial Bulletin.*

Cooke & Co., 22 Cortlandt street, New York, have been made sole representatives in their vicinity of the Dodge patent wood split pulley. They are able to supply from stock, sizes from 8" to 60" diameter, and from 3" to 60" face. These pulleys are easily put on and taken off the shaft, and they are guaranteed to operate with much slacker belt than pulleys made of iron.

We have received three catalogues from the Frick Company, Waynesboro, Pa., descriptive of the line of engines and machinery built by them. These catalogues embrace cuts and descriptions of refrigerating machinery, "Eclipse" machinery, including a great variety of engines, boilers, etc., and the "Eclipse" Corliss engine. The Corliss engine catalogue contains valuable information for engineers and mechanics.

The National Foundry and Pipe Works, at Scottdale, Pa., are now running steadily, producing a full line of cast pipe, ranging in diameter from 4 to 12 inches. Pipe as large as 36 inches in diameter can be made. They have large contracts for the water departments of Pittsburgh and Allegheny. They also made the pipe for the Bridgewater, the Southwest, and the Chartiers natural gas companies' lines. The fuel used at this plant is natural gas.

The Kansas City *Commercial* says: All the leading foundries in the city are running full time, and some of them find it necessary to run into the night in order to keep pace with their orders. Never before in the history of Kansas City has there been so great a demand for castings for both buildings and cable lines. The latter demand is large, and the forces of men employed in satisfying it is being constantly increased. Prices are firmer as the season advances, although the bulk of the contracts for the year's work has already been let.

The Page Belting Company, of Concord, N. H., report business as very active during the past month, with general trade in their belting, both tanned and "Hercules raw-hide" and in the "Hercules" and tanned lacing very satisfactory. Among the special orders which they have received are the following: Belting for the large new brewery being erected by Frank Jones, of Portsmouth, N. H.; main driving belts and dynamo belts for the electric light plant for the Fitchburg R. R. at North Adams, Mass. A large shipment of "Hercules raw-hide" belting has been made to Tokio, Japan, also a large shipment of "Hercules" lacing to Hamburg, Germany.

Riehlé Bros. Scale and Testing Machine Works, Philadelphia, report more numerous orders and better prospects for a steady and remunerative business than for several years past. Among their recent orders received are for two-30 ton platform scales for weighing heavy boilers, Wm. Cramp & Sons, Phila.; one 12,000 pound extra heavy rolling mill scale for Catasauqua Manufacturing Company; one 5,000 pound foundry testing machine for Houston Car Wheel Company, Houston, Texas; one furnace-charging scale for the Warren Furnace Company, Hackettstown, N. J.; one binder twine testing machine for Jno. F. Bailey & Co., New Hartford, Conn.; one 5,000 pound foundry testing machine for the Edison Machine Works, Schenectady, N. Y., besides numerous other scales, marble working machines, sand sifters, etc.

The directors of the Shawmut Fiber Company, recently organized in Boston to build and run pulp and paper mills at Somerset Mills, Fairfield [Me.], have voted to erect a pulp mill there at once, and preparations are now making for that purpose. The sulphite process will be used, the company having purchased of the American Sulphite Company the right to use all their patents and any improvements on the same they may hereafter obtain. The capacity of the proposed mill is ten tons per day of dry pulp. It is now expected that the company will be manufacturing pulp by August next. They have already commenced piling pulp material on their lands for a busy fall. It is probable that the enterprise will develop into something more than one pulp mill, as it is foreshadowed that, within a few years, this company will probably be operating two pulp mills and one of the largest paper mills in Maine at Somerset Mills. The officers of the company are: President, G. A. Phillips; vice-president, Alexander H. Rice; clerk, Chas. M. Phillips; directors, G. A. Phillips, Alexander H. Rice, Arthur T. Lyman, Dana Estes, E. J. Lawrence, G. H. Newhall, John H. Rice. A capital stock of $150,000 has been subscribed.—*Industrial Journal.*

Machinists' Supplies and Iron.

NEW YORK, May 24, 1888.

Iron—American Pig—The market is at present in an unsettled condition, some of the furnaces having followed the lead of those who reduced prices, while others maintain former prices. We quote Standard brands No. 1 X Foundry at $18 to $19.50, No. 2 X $17 to $18, and Grey Forge. $15 to $16.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Wanted—Men to examine S. S. planes; see p 11.

Wanted—Position by engine and boiler specialist. W. H. Booth, care AM. MACHINIST.

Wanted—Position as machine shop foreman by an experienced foreman. F. F. G., AM. MACHINIST.

Wanted—Foundry foreman; must be capable to turn out first-class engine castings. Address 522 West Fifth street, Davenport, Iowa.

Wanted—Situation as master mechanic or supt.; good designer; large exp. on all kinds of work, pumping mach'ry especially; refs. D. S., AM. MACHINIST

Mechanical draftsman wanted; we have a vacancy for one who has had experience in hydraulic work. Buckeye Iron and Brass Works, Dayton, O

Wanted—A thorough and practical machinist to take charge of machine shop; must be well posted on saw mills and general job work. Address Okey K. Cole, Parkersville, W. Va.

Wanted—Foreman to take charge of machine shop who is thoroughly conversant with engine and jobbing work; state age, experience and references; first-class opportunity for proper party. Address Iron Works, care Savage & Farnum, Detroit, Mich.

MISCELLANEOUS WANTS.

Advertisements will be inserted under this head at 35 cents per line, each insertion.

The Cyclone Steam Flue Cleaner is king, and ha no rival. Crescent Mfg. Co., Cleveland, Ohio.

Crescent grease cup for shafting beats them all. Sample free. Crescent Mfg. Co., Cleveland, Ohio.

Wanted—Parties having machinery specialties to build, to correspond with. BOX 75, AM. MACHINIST.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

For Sale—Crosby indicator, in first-class order. F. McSwegan, 3 Dover st., N. Y.

Adamantine adhesive for making steam joints; stops leaks in boilers, stops pitting. Chas. Barnes & Co., Cincinnati, Ohio.

Wanted—Parties having specialties to manufacture, correspond with Cedar Point Foundry and Machine Shop, Port Henry, Essex Co., N. Y.

Wanted—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert streets, Cincinnati, Ohio.

For Sale—My patent flue cleaner, or would like to get it man'f'd on royalty; see cut in this paper, June 9, 1888. For further information address E. D. Weston, Jackson, Mich.

For Sale—In Birmingham, Ala., machine shop, equipped with best make of new mach'y; a bargain for most any manufacturer with moderate capital. Opportunity, AM. MACHINIST.

Machine shop and foundry for sale, to rent, or partner wanted. Very good location, with two rail roads running by shop; poor health the cause of this offer. Address G. R. H., AM. MACHINIST.

For Sale.—Horizontal tubular boiler, 6 x 18 feet: 80 four-inch tubes, steel shell, nearly new; two slide valve engines, Burdon pattern; one 15 x 36, one 12 x 24; can be seen running at 30 Tiffany pl., Brooklyn.

August C. Christensen, M. Am. S. M. E., 24 State st. (Battery), N. Y.; 463 Henry st., Brooklyn. Working drawings and superintending the building of machinery; steam, pumping and gas engines indicated.

For Sale—A 400 horse-power vertical engine, 22 inch diameter, 30 inch stroke, 10 inch steel shaft, two pulleys, 12 feet diameter each, for 18 inch belt. Automatic cut-off, balanced steam valve, speeded for 150 revolutions per minute. Weight, 65,000 pounds. Designed and built by Prof. John E. Sweet, of the Straight Line Engine Co. A first-class machine, practically new. Address W. B. Cogswell, Gen'l Manager, The Solvay Process Co., Syracuse, N. Y.

THE CAMPBELL MACHINE CO.

is very thoroughly equipped to do first-class machinist work, in experimenting, model making, and building of all kinds of fine light Machinery and Tools.

Superior Workmanship at Reasonable Prices.

Address CAMPBELL MACHINE CO.,

PAWTUCKET, R. I.

CURTIS RETURN-STEAM TRAP

For returning steam, condensed under pressure, automatically into the boiler, under high or low pressure,

Manufactured by

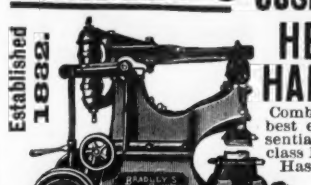
CURTIS REGULATOR CO.

Boston, Mass.

General Agencies:
109 Liberty St., N. Y.
66 N. 4th St., Phila., Pa.
108 5th Ave., Chicago, Ill.
210 S. 3d St., Minneapolis, Minn.
707 Market St., St. Louis, Mo

Send for Circular No. 17.

BRADLEY'S UPRIGHT CUSHIONED HELVE HAMMER



Combines all the best elements essential in a first-class Hammer. Has more good points, does more and better work and costs less for repairs than any other Hammer in the World.

Bradley's HEATING FORGES

With a manufacturing experience of over half a century, we recommend these machines to be the best, simplest, most durable and combining all the essential elements.

For hard coal or coke. Indispensable in all shops to keep Bradley's Cushioned Hammers and men fully employed and reduces cost of production.

BRADLEY & CO., Syracuse, N. Y.

STEPHENS PATENT VISES.

ONE HALF TIME and LABOR saved by using this solid, strong, durable, firm hold, quick-working Lever (Not Screw) Vise. Has improved Taper Pipe and other attachments. Sold by the trade. Send for circular.

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95 Chambers Street, New York.
Successors to MELVIN STEPHENS.

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FOR SAW MILLS, FOUNDRIES AND MACHINE SHOPS.

For Circulars address
THE TANITE COMPANY, STROUDSBURG, MONROE CO., PA.
Or H. A. ROGERS, 19 John St., N. Y.

"Star" Foot Lathe Swings 9x25 in.

Screw Cutting Automatic Cross Feed, etc.

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Scroll Saws, Circular Saws, Lathes Mortisers.

Catalogue Free of all our Machinery.

Seneca Falls Mfg. Co. 687 Water St., Seneca Falls, N.Y

American Standard Gauge & Tool Works, Wilmington, Del.
Makers of Implements for Standard Measurements.

Over 35,000 in Use.

Crescent Gauge. Flat Bar Gauge.

JAS. A. TAYLOR & CO.

THE HUSSEY RE-HEATER

RE-HEATS EXHAUST STEAM.

Super-Heats Live Steam, Heats Air or Water

WITHOUT COST.

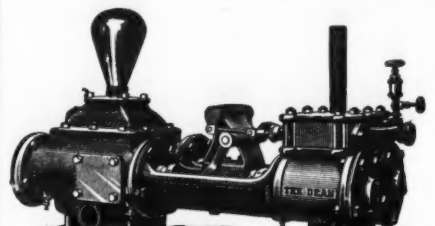
The Hussey Re-Heater and Steam Plant,

IMPROVEMENT CO.

A. S. HATCH, President.
S. D. BREWER, Gen'l Manager. 15 Cortlandt St., N. Y.

93 Liberty St., NEW YORK. | 113 Federal St., BOSTON.

IMPROVED PUMPING MACHINERY For Every Class of Work | Send for New Illustrated **CATALOGUE.**



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Manufacturers of

STEAM and POWER

PUMPS

FOR ALL PURPOSES.

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MACHINE TOOLS ON HAND FOR IMMEDIATE DELIVERY.

15in., 24in. and 25in. Pillar Shapers. 15in. and 20in. Traverse Shapers. 10in., 16in. and 22in. Planers. 18in. x 6, 8, 10 or 12ft. Engine Lathes, (New Pattern.) 10, 12 and 15in. Speed Lathes. Larger size Planers at short notice. Also our Forming Lathe for special brass work. A few 2d hand tools also on hand.

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THE REASON

You now find so much CRESCENT STEEL used in large shops, where results are closely watched, is on account of the superior quality and quantity of work done by tools made from it.

MILLER, METCALF & PARKIN,

Western Office and Warehouse, 64 and 66 So. Clinton St., Chicago. CRESCENT STEEL WORKS, Pittsburgh, Pa. Eastern Office and Warehouse, 430 Pearl St., New York.

Sebastian, May & Co.'s Improved Screw Cutting FOOT AND LATHES POWER

Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.

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OUR NEW 18 in. POWER ENGINE LATHE IS NOW READY

GUILD & GARRISON, Kent Ave. and South 10th St., Brooklyn, N.Y.

Builders of Steam Pumps, Vacuum Pumps, Vacuum Apparatus, Filter-press Pumps, Air Compressors, etc.

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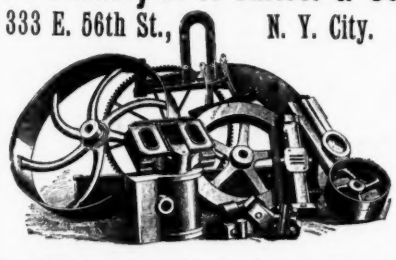
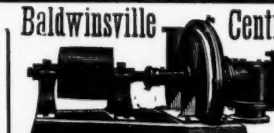
333 E. 56th St., N. Y. City.



Nice Castings, Smooth and True to Patterns, of very best brands of Pig Iron.

CASTINGS IN QUANTITY AT FAVORABLE PRICES.

Baldwinsville Centrifugal PUMP WORKS.



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SYRACUSE, N.Y.
Vertical, Horizontal and Suction Pumps.
Capacity 100 to 40,000 gals. per minute. Sand Pumping Outfits a Specialty.

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Successors to FORBES & CURTIS,
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The Forbes Pat. Die Stock,

Pipe Cutting and Threading Machine, etc.

A portable cutting and threading machine with which one man can with ease thread pipe up to six inch diam. No vise is required.

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TOOLS, SUPPLIES AND MACHINERY

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Wood Split Pulleys.

Lighter than Iron.

Greater traction than Iron.

Bushing system allows each pulley to be fitted to 22 sizes of shafts.

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Shafting, Hangers, Engines, Boilers, Etc.

Write for prices, mentioning this paper.

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MADE BY

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GENTLEMEN:—Replying to your favor of the 18th inst. it affords us pleasure to inform you that the 7-foot boring and turning mill furnished us about one year ago has been in every way satisfactory. We pronounce it a good tool. Yours truly,

RIVERSIDE IRON WORKS.

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Having the Increment Cut.

The illustrations herewith presented exhibit more convenient and durable forms of **File Cleaners** than are usually found, the majority of those in use being rudely devised and troublesome, and we believe, for this reason, those of our manufacture will find a ready sale. Machinists and others who have not already given them a trial, will find it to their advantage to order the **File Card** and **File Brush** at once.

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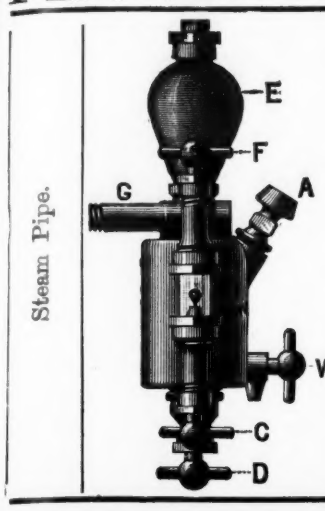

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For Stationary Engines and Pumps of all kinds. Lubricators for Single or Double Connection.

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Nos.	1	2	3
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Capacity	⅛ pt.	¼ pt.	¾ pt.

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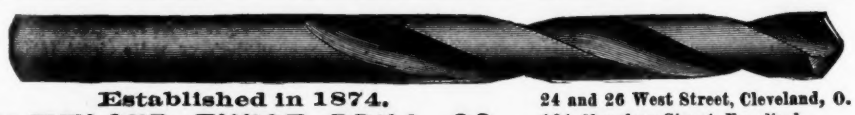

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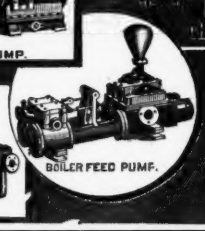
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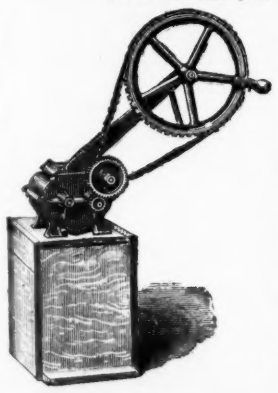
For Blacksmiths, etc. Slow Speed, Positive Blast. Is Durable, Compact and Cheap; also Portable Forges, Tuyere Irons and Foundry Blowers.



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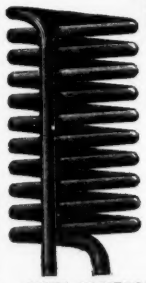

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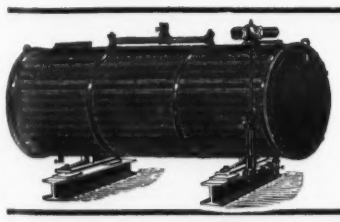

The HOPPES Live-Steam Feed-Water Purifier,

Guaranteed to Prevent Scale in Boilers,

Using any kind of water. Hard Sheet Steel Troughs, *Easily Cleaned.*

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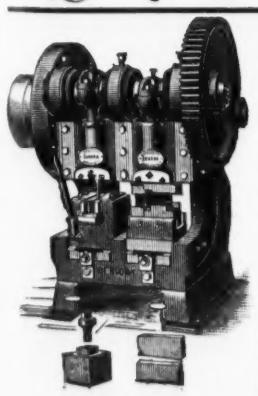

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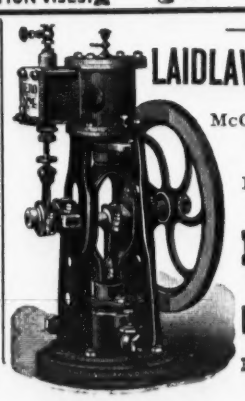

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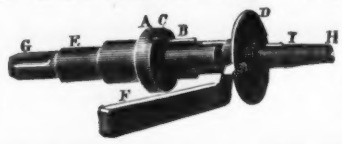

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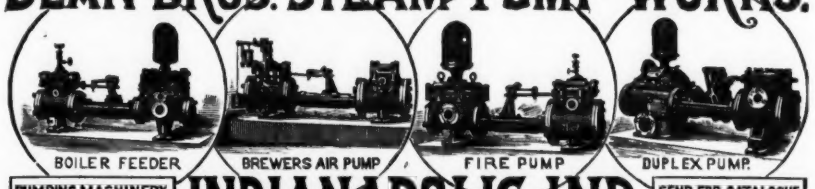

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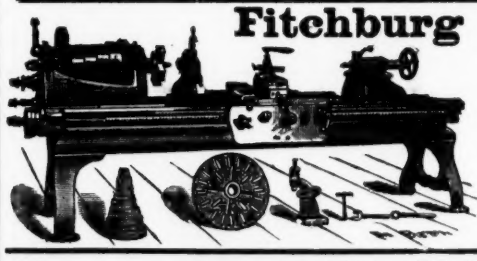

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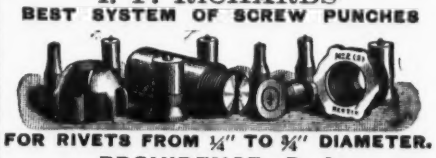

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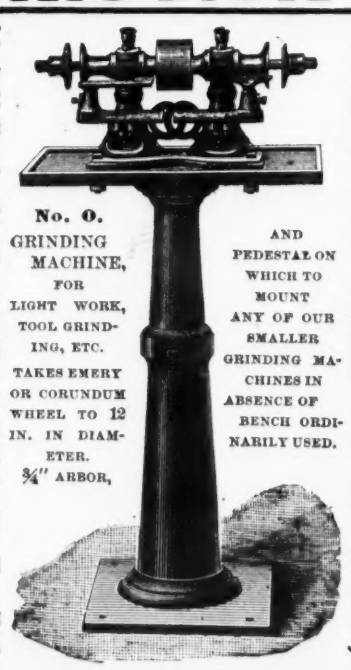

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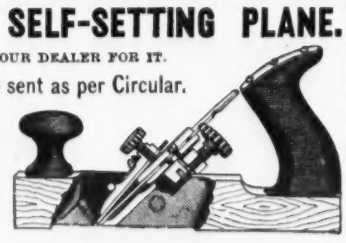

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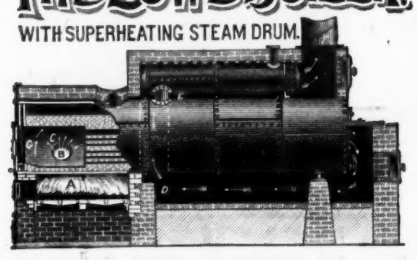

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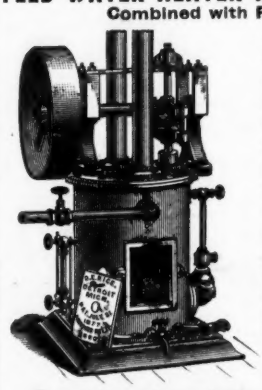

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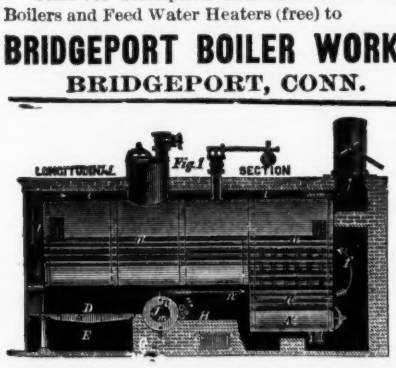

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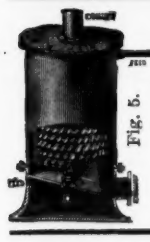

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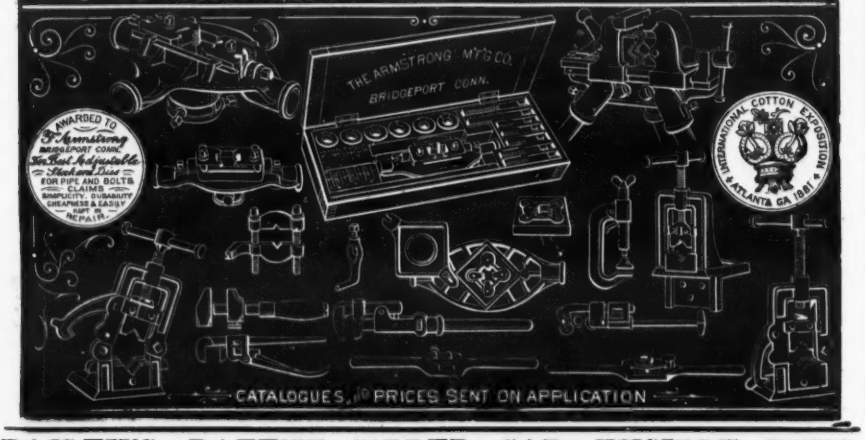

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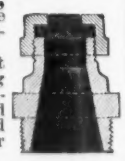

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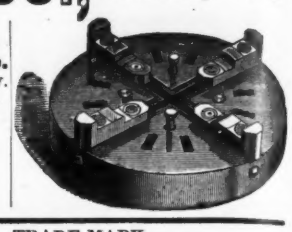

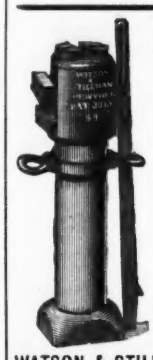

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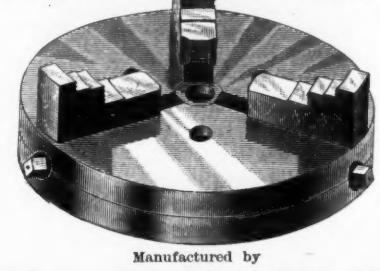

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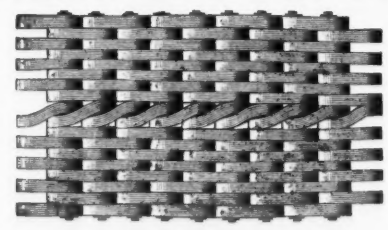

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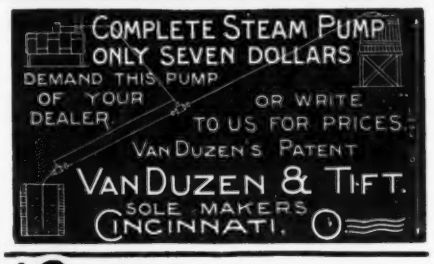

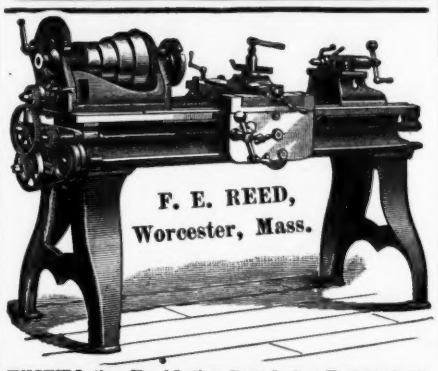

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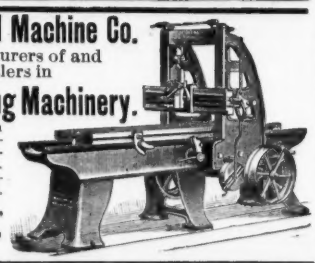

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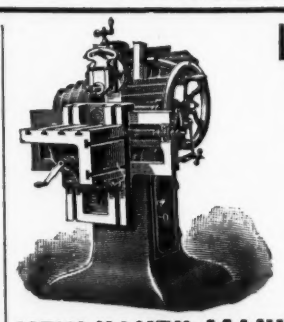

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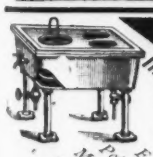

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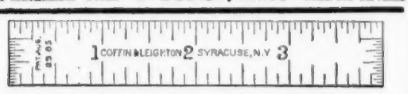

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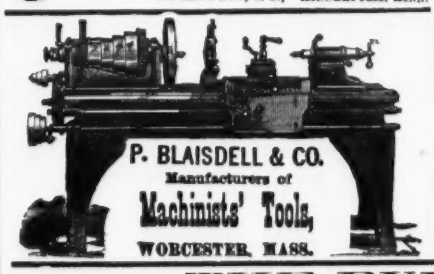

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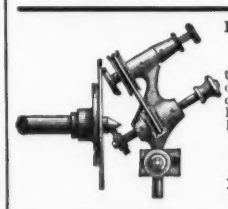

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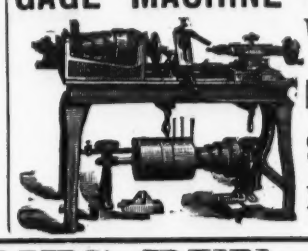

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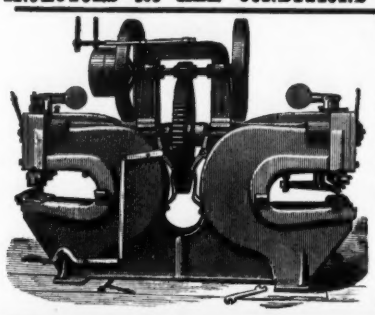

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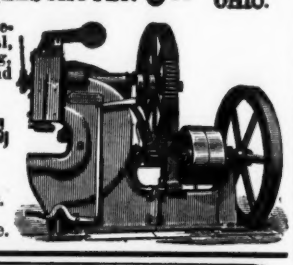

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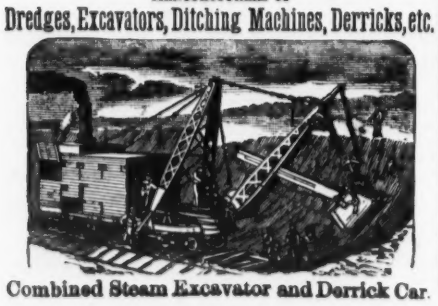

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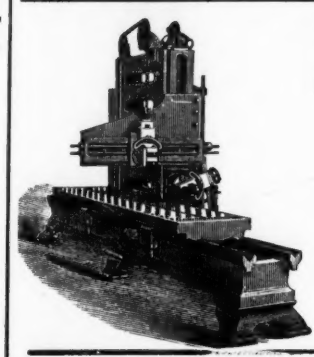

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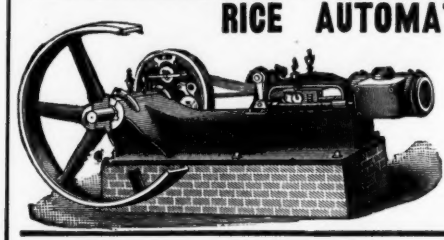

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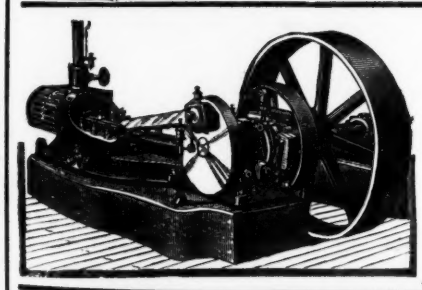

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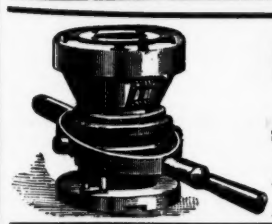

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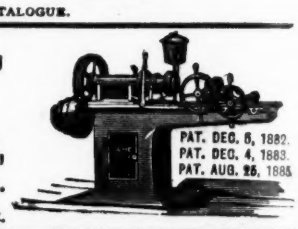

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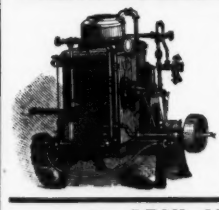

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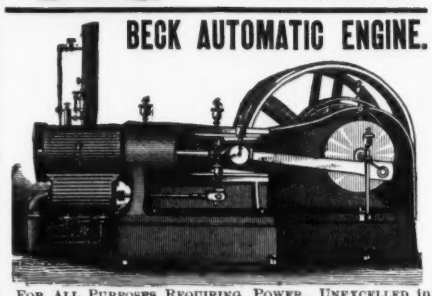

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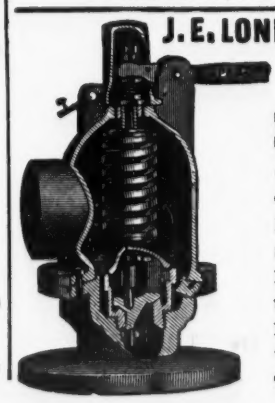

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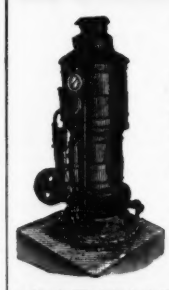

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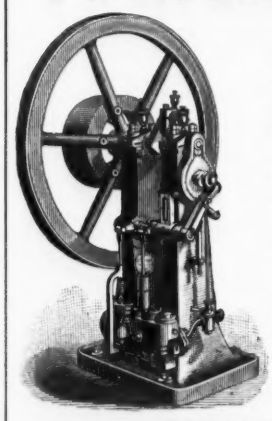

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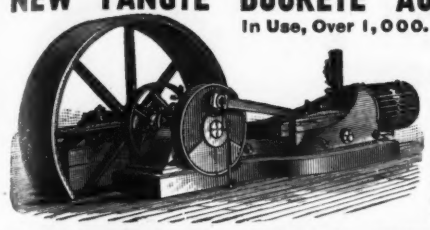

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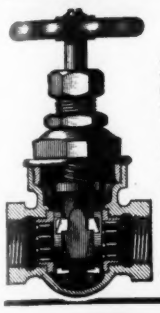

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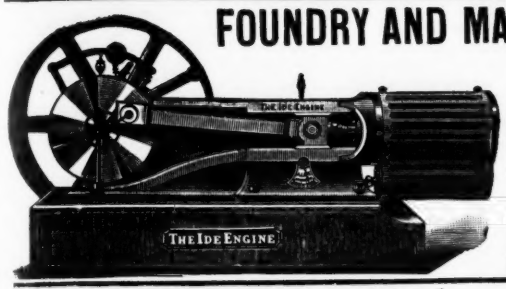

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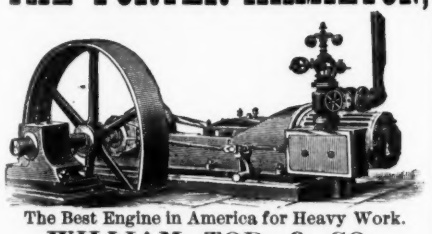

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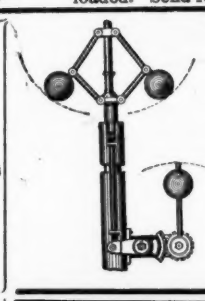
20 in. Drill		Davis,	new.
20-23-25-28 inch Drills		Blaisdell,	"
20-25-28-32 inch	"	C. & S.	"
32 in. Drill		Putnam,	A 1.
36 in.	"	Gould,	cheap.
5 ft. Am. Universal Radial Drill,			new.
No. 1 and 3 Universal Miller, Brown & Sharpe,			"
No. 1-2 and 6 Plain "	"	"	"
No. 1 and 2 Universal Grinder,	"	"	"

Cold Rolled Shafting in Stock. Send for list. Write for what is wanted.

E. P. BULLARD,

62 College Place & 72 Warren St., New York.



WILSON'S SPEED CONTROLLER,

As attached to the Governor of a Corliss Engine, made only by

Remington Machine Co.,

BUILDERS OF CORLISS ENGINES,

BOILER MAKERS AND BRASS FOUNDERS.

Wilmington, Del.

PRESSES, DIES AND OTHER SHEET-METAL TOOLS

FERRACUTE MACHINE CO. BRIDGETON, N. JERSEY, U.S.A.

IMPORTANT!

We are now placing on the market 17", 24", and 27" Engine Lathes, same design and construction as our celebrated 19" and 21" Lathes.

We shall produce them in large lots, in order that we may be able to offer them at the popular prices that induced the unprecedented sale of our 19" and 21" Lathes.

Weight of 24" with 10 ft. bed, 5200 lbs.

Weight of 27" with 10 ft. bed, 6500 lbs.

We furnish, without extra charge, *Taper Attachment, Compound Rest, Automatic Stop for Carriage, Pulley Rest, Etc.*, in addition to regular attachments.

WRITE FOR PRICES, WITH CUTS AND DESCRIPTIONS.

LODGE, DAVIS & CO.

MANUFACTURERS

Machine Tools,

159, 161, 163 and 165 EGGLESTON AVE.,

136, 138, 146, 148, 150, 152, 154 E. 6th St.

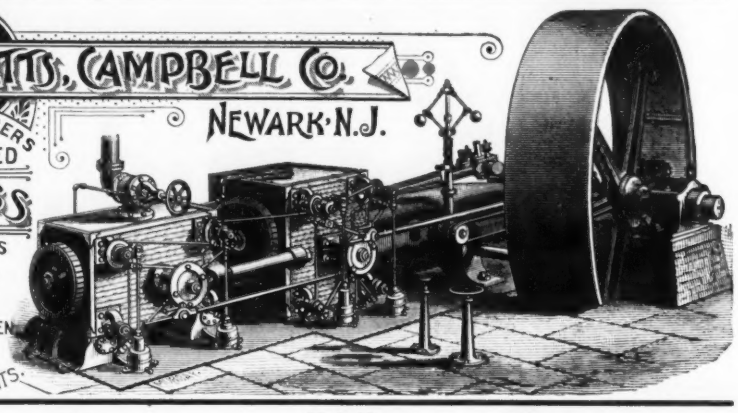
CINCINNATI, OHIO.

(See our advertisement on last page.)

THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

NEWARK, N.J.



CONTRACTS TAKEN FOR COMPLETE POWER PLANTS.

The HEWES & PHILLIPS IRON WORKS

Complete Motive Power Plants Furnished.

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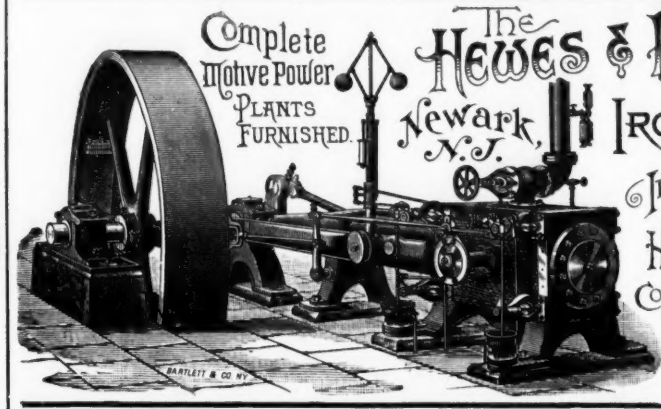


Improved CORLISS ENGINES. High Pressure. Condensing and Compound TUBULAR BOILERS.

GEO. A. BARNARD · AGENT ·

Eclipse Corliss Engine.

FRICK COMPANY, Builders,

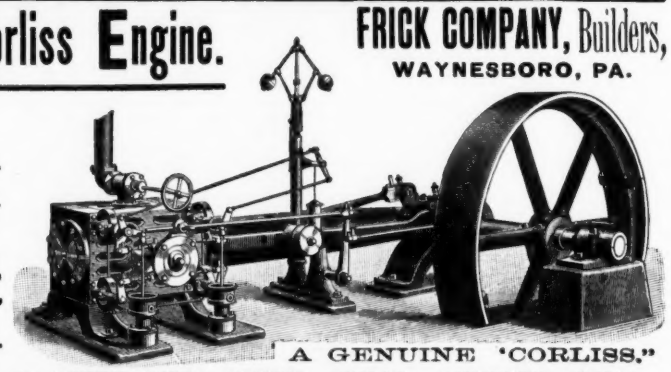
WAYNESBORO, PA.

Non-Condensing, Condensing, Compound.

40 TO 1,000 H.P.

Send for Circulars.

E. P. HAMPSON & CO., 36 CORTLANDT ST., NEW YORK, Sole Eastern Agents.



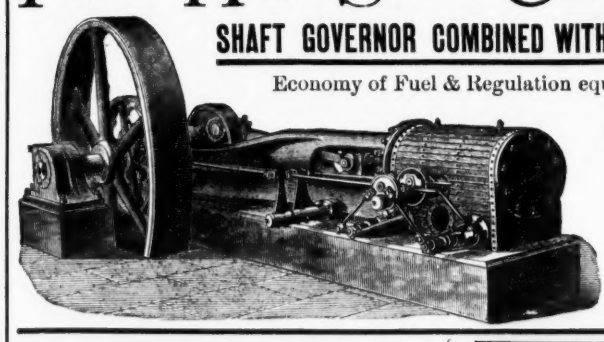
A GENUINE 'CORLISS.'

M. J. TIERNEY, 20 NORTH CANAL STREET, CHICAGO, WESTERN AGENT.

PAYNE HIGH SPEED CORLISS ENGINE.

SHAFT GOVERNOR COMBINED WITH CORLISS WRIST-PLATE.

Economy of Fuel & Regulation equal to anything in use.



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Hill, Clarke & Co., Boston, Mass.

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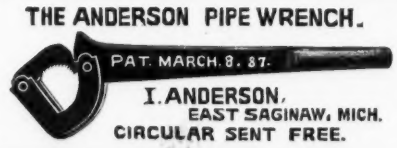

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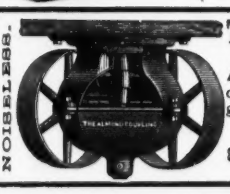

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A NEW quarter turn motion to replace quarter turn belts and bevel gears.

T. R. ALMOND, MFR., 83 and 85 Washington Street, BROOKLYN, N. Y.

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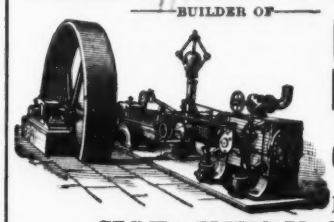

CORLISS Engines, AIR Compressors and BOILERS.

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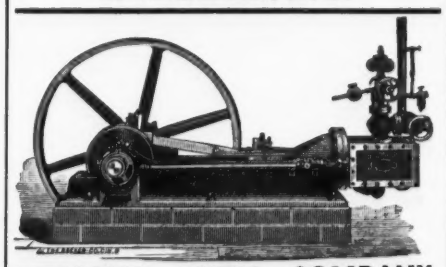


STEARNS M'F'G COMPANY,

ERIE, PA.

ENGINES from 15 to 400 Horse Power.

Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogues.

SAW MILLS and GENERAL MACHINERY.

Works at Erie, Pa.

New York Store, 46 Cortlandt Street,

SMITH & BARNHURST, Managers

HILL, CLARKE & CO.

List of Second-Hand Machines, taken in Exchange for New Tools.

24 in. Swing	22 ft.	Bed Shafting Lathe,	Providence.
36 " "	12 "	" Engine "	Putnam.
33 " "	12 "	" " "	Portland Co.
18 " "	8 "	" " "	Flather.
18 " "	7 "	" " "	David W. Pond.
17 " "	5¼ "	" " "	Shepard.
15 " "	6 "	" " "	Fitchburg.
12 " "	5 "	" " "	Prentice.

Putnam Gap Chucking Lathe, 60 in. swing, 9 ft. bed.
Monitor Brass Lathe, 18 in. swing, 5 ft. bed.
Small Planer, planes 16 in. wide, 3 ft. long. G'd order

Providence	"	"	24	"	"	5	"	" "
Hendey	"	"	26	"	"	6	"	" c'dt'n.
Bement	"	"	30	"	"	8	"	" "

Hendey Shaper. 24 in. stroke. Fine condition.
Wiley and Russell Bolt Cutter No. 5, cuts ¾ to 1¼"
Brown & Sharpe Screw Machine No. 5, largest size.
Brainard No. 7 Milling Machine with Vise.
Car Wheel Borer, 48 in. swing. Fine condition.
Brainard Gear Cutter, 30 in. Automatic Feed.
" " " 18 " " "
Garvin No. 2 Gang Drill, 2 spindles.
" " 4 " 4 "
Pratt & Whitney Vertical Tapping Machines.
" 2 in. Cutting-off Machine.

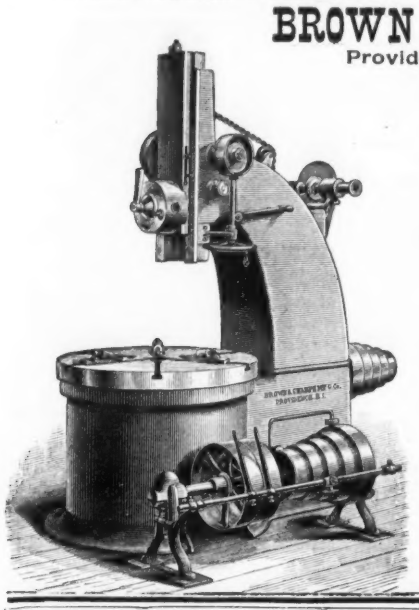
Send for our List of new Tools. We carry much the largest stock in the country.

156 Oliver St., - Boston.

BROWN & SHARPE MFG. CO.,

Providence, R. I., Manufacturers of

MACHINERY AND TOOLS.



Description of No. 2 Vertical Chucking Machine.

Patented August 4th, 1885.

With this Machine from two to four times as much work can be accomplished in a given time as can be done upon an Engine Lathe, and in a much superior manner, the work being more easily trued and fastened in place, than upon any machine having a horizontal spindle, and the different tools in the turret-head easily brought into operation in succession, while from the perpendicular position of the same, the chips fall through the center of spindle of revolving table to the floor, causing no trouble by clogging of reamers, &c.

It has the Capacity to take a pulley 36 in. diam., 18 in. face, and hub of 12 in. in length, and to bore a 4 in. hole in same, making two or three cuts, and finish by reaming, without removing the tools or work.

The Revolving Table is driven by a 5-step cone for 3-in. belt, and geared 6 to 1. Steps of cone so graded as to make cutting speed uniform for 5 different diameters of holes.

The Turret has 4 holes 1 3-4 in. in diameter, and is securely clamped in position. An adjustable dog allows the locking pin to be withdrawn at any part of its upward motion.

The Turret Slide has a movement of 21 in., and an automatic feed which can be easily and quickly changed from the finest ever needed to the coarsest required, it has quick return by hand, and is counterbalanced by a weight inside of column.

Price includes countershaft, wrenches, &c., all complete, delivered f. o. b. at Providence, R. I. Weight, 4,400 lbs.

ILLUSTRATED CATALOGUE MAILED ON APPLICATION.

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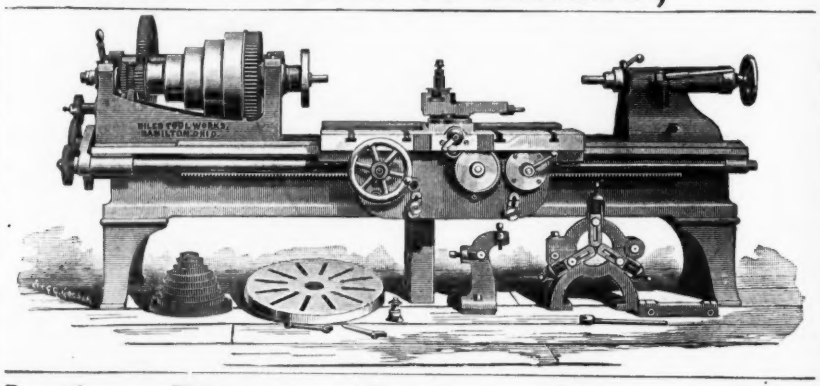
23 South Canal St., Chicago, Ill.

NILES TOOL WORKS, HAMILTON, OHIO.

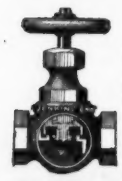


Lathes, Planers, Shapers, Slotters, Etc.

CRANES

THE YALE & TOWNE MFG CO.
STAMFORD CONN
NEW YORK. CHICAGO. PHILA. BOSTON

IMPORTANT TO USERS OF VALVES.



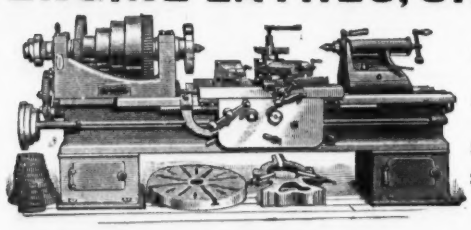
Owing to the popularity the JENKINS BROS. VALVES have attained, the market has been subjected to BASE IMITATIONS.

One important defect in the imitations referred to is *insufficient opening* for inlet *of steam or* Fluid, *thereby checking the flow.* Purchasers of Valves should be careful to know that they are of capacity suited to size of pipe to which the Valves are to be attached. All Valves manufactured by

Jenkins Bros. are Warranted Full Opening.

JENKINS BROS., 71 John St., N.Y. 105 Milk St., Boston. 13 So. Fourth St., Phila. 54 Dearborn St., Chicago.

ENGINE LATHES, SHAPERS & DRILLS



15" 20" 26" 32" Shapers.

17" 19" 21" 24" 27" Engine Lathes.

20" 24" Upright Drills.

25" 28" 32" 40" B. G. P. F. Drills.

26-INCH BACK GEARED AND POWER FEED DRILL.

LODGE, DAVIS & CO.,

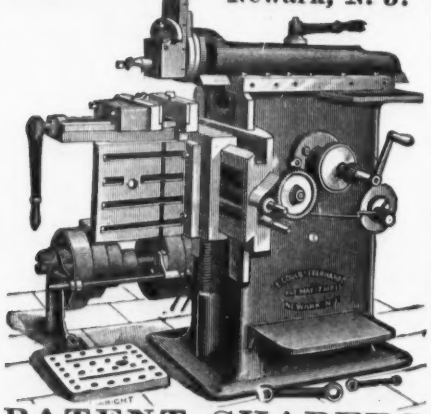
CINCINNATI, OHIO.

Send for Prices. **It will pay you.**

(See "Important" Notice of Engine Lathes on page 15.)

GOULD & EBERHARDT,

Newark, N. J.



PATENT SHAPERS.

Sizes, 10", 15", 20", 25" and 30" in stock.

NEARLY 1,500 IN USE.

GEAR AND RACK CUTTING TO ORDER.

E. E. CARVIN & CO.,

MANUFACTURERS OF

Machinists and Iron Workers' Tools.

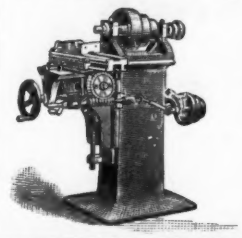
Universal Milling Machine.

Lathes, Planers, Milling Machines and Drills. Special Tools for all kinds of manufacturing to order. Gear and Rack Cutting, Milling and Index Drilling to order.

Nos. 139 to 143 CENTRE ST., NEW YORK.

THE PRATT & WHITNEY CO.

Hartford, Conn.



Manufacture Plain Milling Machines, with hand and power feed, of several sizes. Index, double face, vertical face, double spindle and shuttle race Milling Machines. Cam Cutters and Profiling Machines of several kinds. Milling Machines, Vises and Centers. Milling Cutter and Twist Drill Grinding Machines.

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KNURLING TOOLS. CUTTERS FOR THE TEETH OF SPUR WHEELS.

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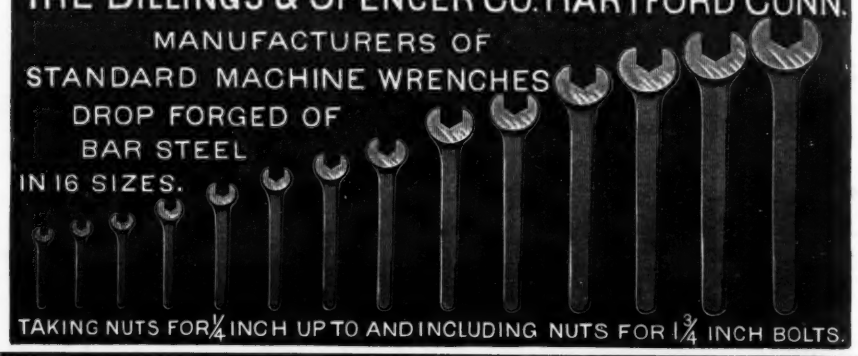
STANDARD MACHINE WRENCHES
DROP FORGED OF
BAR STEEL
IN 16 SIZES.



TAKING NUTS FOR 1/4 INCH UP TO AND INCLUDING NUTS FOR 1 3/4 INCH BOLTS.

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BRASS WORKING MACHINERY

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THE POND MACHINE TOOL COMPANY,

Formerly of Worcester, Mass.

The new shops of this company are located at Plainfield, N. J., forty minutes' ride from New York city on the line of the Central Railroad of N. J., and consist of the following:

A machine shop 500' long by 100' wide; a foundry 250' long by 90' wide; also commodious buildings for the storage of sand, coal, coke and pig iron; ample and convenient wash rooms for the men; fireproof two story pattern storage; blacksmith shop; engine and boiler houses. These buildings are detached from the machine shop and foundry. There is an elevated railroad for the convenient distribution of raw materials, and a railroad running through the machine shop for shipping. The whole plant is supplied with the incandescent system of electric lighting.

The machine shop and foundry have overhead traveling cranes running through their entire lengths; also light traveling cranes, which serve every tool, and a number of jib cranes in the foundry and scratch rooms. The foundry has capacity for making the heaviest class of castings.

All our tools are expressly designed for the economical manufacture of heavy machinery for railroad and general machine shop equipment, from new patterns of the latest and best designs.

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ENGINE LATHES

FROM 16 to 48 IN. SWING.

Cuts, Photographs and Prices furnished on application.

Lowell, Mass., U. S. A.

Gear Wheels and Gear Cutting.—I make g to order, or cut teeth on g blanks sent to me. Of all kinds. Of all sizes to six ft. dm. Small orders or large ones. Fine g or cheap g. Small cast g. Ready made brass g by mail at low prices. Bevel g with perfect planed teeth. Hand Book on g, $1. Facilities complete. Terms reasonable. Send for cat.
GEO. B. GRANT, 66 Beverly St., Boston, Mass.

KEY-SEATING MACHINES

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20 in. Drills a Specialty.

Our 20 in. Drill is a heavy, substantial tool, made for service, has steel shafts and spindle. Gears and racks cut from the solid, and have all modern improvements, are made by special machinery, and sold very low.

Our Key-Seating Machine will save enough in 60 days' use to pay first cost; no shop can afford to do without one. We have now ready for prompt shipment, both Key-Seat Machines and 20 in. Drills. Send for Photo. and Catalogue.

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J. M. ALLEN, President.
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Lathes and Planers

FOR ALL PURPOSES.

THE G. A. GRAY CO.,

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Photographs and prices sent upon application.

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PROPRIETORS
Buffalo Steel Foundry,
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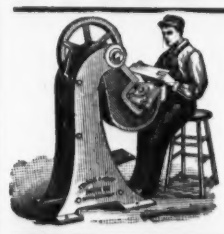

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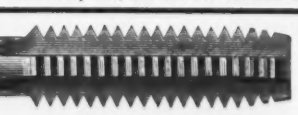

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